CHEMICAL & METALLURGICAL ENGINEERING

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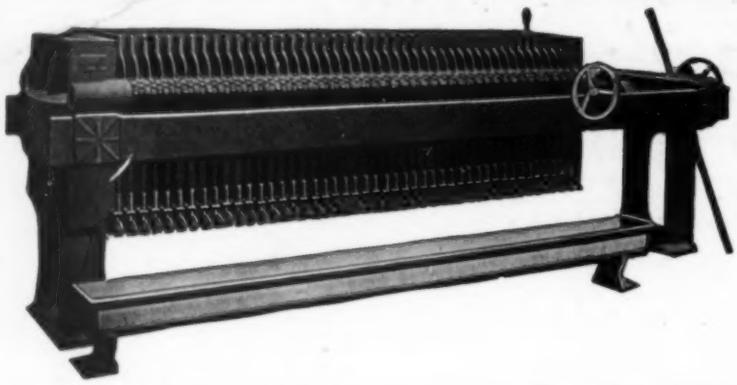

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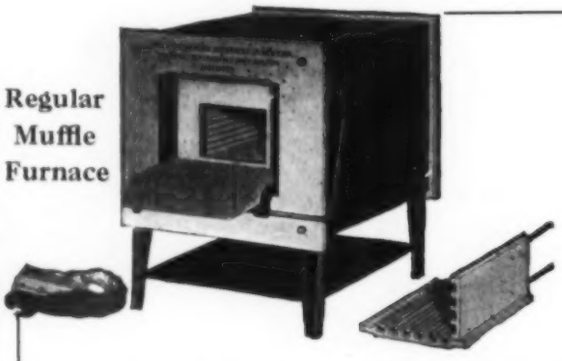

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Recognizing Our Organic Chemical Industry

AN EVENT of historical importance to the chemical industry occurred in Washington last week at the meeting which resulted in the organization of the Synthetic Organic Chemical Manufacturers Association. This new economic factor carries with it more significance than the usual trade association, for it marks the union of all the elements which go to make up our organic chemical industry. The manufacture of pharmaceuticals, synthetic drugs, aromatic, photographic and other fine chemicals is to be recognized as essential, if not equivalent, parts of an industry of which dyes and intermediates are only an important branch.

The association has wisely selected Dr. CHARLES H. HERTY, editor of the *Journal of Industrial and Engineering Chemistry*, to be its first president. His vigorous enthusiasm and indomitable spirit have won for him a position second to none in the fight for the adequate recognition of American chemical industry.

Railroad Strike Is Called Off

BEATING an ignominious retreat, the railroad labor leaders decided on October 27 to call off the strike of the five railroad brotherhoods and thus relieve business of the apprehension under which it has labored for several weeks past. In explanation of their action, Mr. SHEPPARD, president of the Order of Railway Conductors, is reported to have recognized the fact that public opinion had discountenanced the strike and that the Government had decided to marshal all its forces against the strike, should it be called. Had he stopped at that explanation his words would have commanded the respect that is due a man who sees the light and acts accordingly, but he weakened his cause by his reported statement that the railroads had succeeded "in their misleading propaganda to the effect that we really would be striking against the Government." No sane man had ever thought otherwise.

One other phase of the strike cancellation, as reported in the daily press, will be worth remembering. It is stated that after reaching the decision to cancel the strike "all of the union men were smiling as they came out and many of them jocularly pushed and shoved each other down the stairs." A ghastly joke, indeed, that they had played on American business, causing disturbance, unrest, uneasiness and apprehension for weeks, only to yield at last to the authority which they should have respected in the beginning. One is forced to the conclusion that the leaders never intended to call the strike and that the vote was used only as a club to coerce the Government into meeting their demands. Labor leaders have only to continue to play this kind of joke on the American public to experience for themselves and followers the fate of the one who cried "Wolf! Wolf!"

How to Reduce Taxes

THE future of the coal-tar dye industry is, alas, in the lap of politics. We had hoped that it would forge ahead, establishing itself by its own merits; we watched with interest and enthusiasm the extraordinary achievements of American chemists, as they accomplished forty years' work within the space of five years, and we hoped that this great feat would speak for itself. Instead of this the industry has been made the butt of undeserved complaint. Sometimes it seems as though, as a sequel of war, people have gone to the dogs for their principles as well as for their habits of thought!

At the last count we had 213 concerns making coal-tar products and eighty-two making synthetic dyes in the United States. They are making today 90 to 95 per cent of the dyes needed and used. And they are good dyes, despite the fact that the markets are flooded with wares that fade out on almost any provocation. We have discussed this matter before, but let's repeat a little of it to bring out the facts. We buy, for instance, a pair of black socks, and when they come back from the wash they are a dirty greenish gray. The dealer, to whom we complain, regrets that he cannot guarantee goods colored with American dyes. Now there never was made any better sulphur black than is made right here in this country. But while sulphur black costs 20 cents a pound and direct black $1.10, it is much cheaper to dye with the latter, because it requires scarcely any work to put it on. Sulphur black, on the other hand, must be developed on the fiber, and that takes time and labor; and wages are high in the dyehouses. So the owner of the goods while they are in process has them dyed by the cheaper method, and direct black will not stand laundering, but sulphur black, rightly applied, will. This holds true all the way down the line; it requires labor and handling and care to put the right dye on the goods so that it will hold. The value of the dye that goes on a single garment is negligible. The main cost is the labor of putting it on. The difference between the cost of wearing apparel with German dyes free of duty and under embargo is a small fraction of a cent on a pair of socks and a few cents on a suit of clothes or a woman's dress. And every dye is available to the dyer.

Suppose our license system or embargo were allowed to lapse, what would happen? The Interessen Gemeinschaft, or German Dye Trust, has packed up, awaiting shipment, immense supplies of dyes of all sorts. Within two weeks it can land in New York, in two ships, dyes to supply the American market for more than a year. It can pay any duties we want to impose, its costs are one-half to one-third of American costs and while Germany is poor the I. G. is rich. Just two weeks' privilege under any kind of a tariff will enable it to kill the American industry.

Well, what of it? Most people don't care very much where the dyes are made that color their clothes. Financially speaking the industry is not important. All the dyes used in the country in a year amount in value to only a few months' sales of the Woolworth 5 and 10 cent stores. The profits or losses of the dye manufacturers do not constitute a national issue. True, no industry requires so many trained chemists in proportion to its product, but even that scarcely touches public opinion. If chemists lose their jobs, so do others. Why worry? Why make such a fuss over this thing? Just a little patience, please, and we shall reach the core of the problem.

We are talking of reducing armaments, and LORD knows we all want big armaments and big armies and navies reduced. We are sick of war, although we have not yet learned to put aside that which above all other things leads to war, which is the spirit of anger and hatred and mistrust. There is so much hair-trigger wrath abroad on earth that no nation can afford to give up all thought of defense at this time, although the costs of defense are killing costs.

In the meantime, chemical warfare has arrived. Nobody likes it, but it is bound to endure because it is more effective than powder and ball. One battalion of well-trained C.W.S. troops with proper materials can utterly defeat a whole brigade. At the beginning of the great war there wasn't any such thing as chemical warfare and at the Armistice 55 per cent of the warfare was chemical. Agreements and treaties will not put an end to it, because the army that uses it against an enemy that does not will win. Efficiency counts.

Now we are struggling under a burden of taxation that is using up our substance, destroying initiative and halting progress, almost wholly because of military costs. And in this very dye industry we have a self-contained arsenal, available for the production of munitions of war, which does not cost the Government one penny, which pays taxes, which does not encourage warfare or make men want to fight, which in times of peace gives us only materials used in peace, but which is ever ready, in time of war, to produce such potential munitions that no nation will dare to attack us. It leads to greater relief from taxation than any measure now before the American people.

Facts and Fancies
About the Oppau Explosion

SIX WEEKS has elapsed since the Oppau disaster, but notwithstanding the extraordinary interest in this subject, the technical press both in this country and abroad has published surprisingly little in the way of a scientific explanation of this calamitous explosion. Chemists and engineers of all countries have studied closely the meager reports which have been published not only for what they contribute to our general knowledge of explosions but also because of the probable effect upon the German nitrogen industry. Explosive experts are especially concerned with the accounts of the nature of the damage and demolition and the distances at which the effects of the explosion were felt. Even the war yielded few if any examples of such tremendous disruptions from which comparable data and experiences could be gained. The catastrophe at Halifax resulting from the explosion of three million pounds of TNT involved only about one-third of the mass of material reported to have exploded at Oppau. On other pages of this issue the reader will find an authentic report of the explosion prepared by one who had an unusual opportunity to study the scene of the disaster. With it are a number of excellent photographs, a careful study of which should prove of value in helping to gage the magnitude of the occurrence and to test the various theories regarding its possible origin.

The fact remains that little is known regarding the real cause of the explosion. The blasting of the caked material with dynamite, which to the uninitiated appears to be extremely hazardous, is common practice in ammonium-nitrate plants both in this country and abroad. Moreover, ammonium sulphonitrate, the mixed salt at Oppau, has always been regarded as non-explosive. The director of the Physikalisch Technische Reichsanstalt was unable to explode the material except when it was tightly packed in iron pipe and given an unusually violent detonation. Recent experiments conducted in this country with crystallized NH_4NO_3-$(NH_4)_2SO_4$ and with intimate mixtures of the two powdered salts tend to confirm this supposition.

The theory of the spontaneous decomposition of the salts, which from the chemists' point of view is at least within the realm of possibility, is regarded as purely speculative by some of the foremost explosive experts. One circumstance, however, which appears to strengthen the argument in favor of this theory is the report that on the night preceding the explosion certain observers had noted a change in color and a slight rise in the temperature of the mass. The bursting of one of the synthetic-ammonia catalyzers, which at first was hailed as a most likely explanation of the premliminary and detonating explosion, is now almost entirely discredited by the photographs showing so little damage to the part of the plant in which the catalyzer bombs were housed.

Furthermore we are confronted with the fact that ammonium nitrate itself is something of a mystery. Those who know anything about powder plants cannot help recalling instances when it acted as it shouldn't. We are told that once upon a time, of twenty vessels working up ammonium nitrate, No. 6 and No. 18 suddenly exploded, demolishing several others. At the same instant some barrels of nitrate in a storage shed went off and only scattered holes in the ground were left to mark the places where they stood. Surrounding barrels were broken and charred, but did not explode.

A very plausible explanation of such an occurrence was to assume that a minute amount of some highly unstable impurity was located somewhere within two or three of the barrels and its peculiar sensitiveness was responsible for the explosion. At Oppau, however, the ammonia used was a synthetic product which should have been unusually free from pyridine and similar impurities contained in ammonia from byproduct coking plants. Nor should nitric acid made by the oxidation of this ammonia contain traces of nitrated cellulose such as are carried over in the spent acid commonly used in powder plants. These are circumstances which undoubtedly would have made for greater stability of the ammonium nitrate prepared from such materials.

Still another very puzzling question is to explain the means by which the explosion spread from one center to another. If we accept the contention that heat, rather than shock or pressure waves, is the primary cause of detonation, we are unable to account for the fact that there is practically no evidence of fire in the

spaces which separate the explosive centers, notwithstanding that much of the wreckage is apparently made up of timber and other flammable material.

It is easy, perhaps, to account for the fact that certain portions of the plant are relatively undamaged while across the river in Mannheim extensive destruction was reported. A phenomenon which has often been noted in connection with large explosions is that the rush of air appears to take a wave-like course, harmlessly passing over one district only to dip down at some distance and wreck havoc with all that comes in its path. This, too, explains why observers in different localities will often report conflicting views regarding the relative intensity of two explosions.

To summarize what we know and don't know about the explosion is a difficult task, but it is certain that much remains to be learned. A scientific review of the facts reported from the scene of the catastrophe and an intensive study of the nature of ammonium nitrate and its mixtures may not explain all of the mysteries of the Oppau explosion, but it will do much to prevent the recurrence of similar disasters.

Earnings in the Steel Industry

THE financial report of the United States Steel Corporation for the third quarter of 1921 is very gratifying from the economic viewpoint, since it shows that it will be possible to cheapen the price of steel still further in the future and thus broaden the opportunity for its use. Wall Street regards the report as "bad, but not nearly as bad as expected."

Estimates made from time to time indicate that the Steel Corporation's shipments of steel products for sale in the September quarter amounted to about 1,200,000 tons, so that with earnings reported of $18,918,058 the earnings were about $15.75 per ton. Shipments averaged only about 30 per cent of capacity, and the earnings were small on that account, not on account of the rate per ton.

Already steel prices make a very fair comparison with pre-war levels, but every dollar a ton reduction will help broaden the demand for steel in future years. On a weighted average, steel prices now are about 28 per cent above the ten-year pre-war average, 34 per cent above the average of 1913 and 63 per cent above the low point of December, 1914.

It is true that independent steel companies have lately been showing large losses, in contrast with the Steel Corporation's profits. The statement frequently made that the Steel Corporation has a great "advantage" over the independents does not provide an explanation for this divergence. The Steel Corporation's inherent advantage is not large per ton, and it existed in 1912 and 1913, when the independents made profits although the Steel Corporation's earnings were $10 per ton against $15 per ton last September or in the September quarter. The explanation rather is that in 1920, when the independents advanced prices freely while the Steel Corporation held its prices down, the independents acquired expensive habits, which must be shaken off. Then there is probably a difference in that the Steel Corporation made radical allowances for excess inventory valuations in 1920, while the independents may have left some of that adjustment for this year. Another factor affecting comparisons at present is that in recent months the Steel Corporation has had a heavier operation than the independents, by reason of good will acquired by the price limitation policy of 1920.

Altogether, the outlook for steel supplies in the future at really very moderate prices is greatly improved.

Social Stepping
A Business Necessity

NOW the season of increased human sociability approaches. Michigan Boulevard squaws, corner grocery habitués, statesmen, working girls, fishermen, profiteers, flappers, engineers, bathers and chemists will soon be forced to spend more time indoors and partake with different degrees of enjoyment of interior recreations. And it is well that nature so orders, for there is a very serious side to the seeming lightness of social frolicking. Social contact with fellow humans has more to do with the success of the individual than the same amount of time spent grinding at work without respite. This applies to personal development and business progress alike.

There is a chap who was so puritanical in his youth that he preached to his high school class against dancing at parties. A kindly old lady took stock of him in his first year at college and talked him into getting a girl and a dress suit. This chemist has never lost his appetite for hard work, but is now so filled with gregariousness that he will travel across the continent to a convention if dancing is among the listed events. He has broadened into a well-poised successful engineer.

EDISON has long been reputed as an inveterate worker, yet we find him in his later and we hope wiser years associating with men in other walks of life. Had he stepped away from the bench occasionally during his earlier years the general philosophy he now propounds would be less ingenuous, more sound. Litterateurs and artists have long dealt with society as a medium for their business activity. Observation of other men's motives has always been their stock in trade. Our more successful scientists count heavily as social bears. Chemists' clubs in Chicago, New York and elsewhere have the community's progressive men of science most active in social affairs.

In past years some scientists have succeeded in spite of their secluded lives, but never because of uninterrupted work within their cells. Since success in chemistry is becoming more a question of industrial application and less a matter of mystifying the public, the individual chemist must develop into a social mixer. As the business man would put it, he must sell himself through his personality and purchase current knowledge with discrimination. Ability to discriminate between buncombe and truth is an art most easily acquired by close study of the human vender. Secluded preachers are easy marks for book agents and overstudious truthseekers soft stuff for blue-sky salesmen, for both types lack experience in reading human character.

Application at the wheel without respite will only grind the rut deeper. Accomplishment of the artisan's task requires that the cutting tool move forward after the proper depth has been reached. Performance of organizations without wastage calls for co-ordination of efforts of all the separate parts. Human contact in a lighter vein is the best co-ordinator. Both the community and the individual profit if each one goes out stepping occasionally. This season is a good time for it.

Readers' Views and Comments

Impact Strength of Monel Metal and Aluminum Bronze

To the Editor of Chemical & Metallurgical Engineering

SIR:—Mr. Waltenberg's description of impact tests on Monel metal, on page 322 of your issue for Aug. 24, brings out very clearly the excellent resistance of this material to shock, but does not seem to do entire justice to other materials with which it might be compared. For instance, it might be expected that a metal with a ductility represented by 45 per cent elongation in 2 in. would have a greater impact resistance than metals with from 2 to 23 per cent elongation, yet these are the only metals on which impact figures are given in this article in comparison with Monel. In spite of the better shock resistance of the latter, it is doubtful if it will displace the heat-treated alloy steels of higher strength from many of their present applications.

Aluminum bronze, however, is an alloy with which Monel metal might well be compared, and some impact results on this alloy would have been of more practical interest in this connection. Reference might be made for this purpose to a "Study of Impact Tests on Alloys," published by A. B. Wilson on page 616 of *The Foundry* for Aug. 1, 1920. Unfortunately the nearest approach to Izod or Charpy tests that he reported are Fremont tests, where the cross-section area of the specimen at the notch was only 10 x 7 mm. instead of 10 x 8 mm., as in Mr. Waltenberg's tests. The extra millimeter in thickness would have a disproportionately greater effect on the results in this test in favor of the Monel metal, so a strict comparison is impossible. But even under these adverse conditions, and on cast material, a figure of 88.4 ft.-lb. was obtained for aluminum bronze, which is higher than that for any of the steels quoted by Mr. Waltenberg. Under the same conditions this figure would undoubtedly approach or surpass the showing of cast Monel metal; and well-annealed titanium-treated cast steel has given even higher figures than this.

The method given for determining the quality factor places a decided premium on the elongation at the expense of the tensile strength, so that Monel metal, with the highest elongation of any of the metals given, is bound to come out ahead. For instance, a common annealed brass would have by this method about the same high quality as the heat-treated nickel-chromium steel. The figures given here for aluminum bronze seem to be minima taken from a specification, instead of good average results like those for Monel metal. By referring again to Mr. Wilson's article mentioned above, it may be seen that proper comparative figures for cast aluminum bronze would be 80,000 tensile strength and 35 per cent elongation, giving a quality factor of 1,167 instead of the 875 obtained from Mr. Waltenberg's figures. This would place aluminum bronze above all but one of the steels, which is about where it belongs in a "quality" comparison of this kind. And it should also be remembered that the figures I have given above are for cast aluminum bronze, and thus subject to more or less improvement by skillful mechanical work.

GEORGE F. COMSTOCK.
Metallurgical Engineer,
Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.

Recovery of Volatile Solvents by the Bregeat Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—My attention has been directed to the letter of Messrs. Roulleux and Dort, in your Aug. 3 issue, in reply to a letter by James C. Lawrence, in your July 20 issue.

As a rule I do not think anything is gained by entering into controversy, but there are several statements in the former letter to which I feel it my duty to take exception, particularly the following: "Until the Bregeat process had been developed solvent recovery was not an industry by itself. The Bregeat process is responsible for bringing solvent recovery out of the class of an incidental and casual art into that of an independent and well-established business." This statement ignores altogether the work done by the Scott Co. which for twenty years has been making and installing solvent recovery apparatus. These installations have been furnished to prominent firms throughout the world for various industrial purposes, whereas the Bregeat plants tabulated in the article published in your issue for May 25 were chiefly, if not wholly, for war-time purposes, installed when expense was not an item to be considered. The number of installations made by the Scott Co. during the last twenty-odd years speaks for itself regarding the work of that firm in developing solvent recovery. The fact that up to the present time British manufacturers have been the largest users of solvent recovery apparatus for industrial purposes and that these installations have been built mainly by British firms is sufficient evidence of where the process has been largely developed.

ERNEST SCOTT & CO.
Fall River, Mass. H. AUSTIN.

Studies in Colorado Shale Oils

To the Editor of Chemical & Metallurgical Engineering

SIR:—On pages 452 and 453 of your Sept. 7 edition apears an article written by Arthur J. Franks in which he makes a statement that for the determination of sulphur, "the peroxide fusion method does not require more time and energy than the oxygen bomb method." My experience in this work has been that considerably more time is required to determine sulphur by the fusion method than by the use of the oxygen bomb washings. The bomb that I have been using is the standard oxygen bomb furnished with the Parr oxygen bomb calorimeter and is equipped with a rubber gasket. I agree with Mr. Franks that when a lead gasket is used some extra time will be required. However, recent determinations made in our laboratory have proved conclusively to me that as far as the time element is concerned the advantage lies in favor of the oxygen bomb method. The results of these determinations, as well as many others I have run, show that more consistent results are obtained by the use of the fusion method, that slightly lower results are given by the oxygen bomb determinations, and as stated before, that much time is saved by using the oxygen bomb.

PAUL F. HOOTS,
Chemist, New Orleans Railway & Light Co.
New Orleans, La.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENEVA, ITALY, Oct. 5, 1921.

SEPTEMBER was a very fair month for the Italian chemical and metallurgical industries, and the number of orders, together with a further rise in foreign exchange, kept prices high. In some cases, especially with goods of foreign importation, there was an increase in price. The greater part of the business remained in the hands of French and German exporters owing to the lower rate of exchange in France and Germany compared with that of the United States and England.

ITALIAN POTASH MINES

The Italian firm Società Mineraia Coloniale Italiana, of Massaua, possesses potash mines capable of producing, when worked under normal conditions, from 5,000 to 8,000 tons per month of potash material. These mines are located in Abyssinia close to the Eritrea frontier, and the mineral is transported to Massaua (Italian Eritrea Colony) in part over land and in part by water through the seaport of Marsa Fatimari. The firm employs, when working full time, more than 1,000 persons, most of whom are natives. In 1917 one-half of the production of the mines was sent to Italy. two-sevenths to France, one-seventh to England and the rest to Egypt. The Italian who discovered the mines in 1911 obtained from the Abyssinian Government a concession for their exploitation for thirty-five years.

ITALIAN SULPHUR INDUSTRY

The crisis in the Sicilian sulphur industry led to several meetings at the Ministry of Industry at Rome, where the representatives of the miners and the workmen insisted that no reduction of present wages should be enforced, as the cost of living has recently increased. The Consorzia Obigatorio per l'Industria Zolfifera Siciliana insisted on the necessity of its being authorized to conduct the refining of sulphur on its own account, or on the authorization to have refining conducted on its own products by the refineries already working. This position is easily understood when it is considered that exportation of refined ground sulphur increased during the first four months of the year to 15,887 tons, from 12,202 tons in 1920 and 5,951 tons in 1919 during the corresponding months and the exports of flowers of sulphur during the same months were 4,406 tons, against 6,921 tons in 1920 and 4,171 tons in 1919. There was also much discussion on the grinding of sulphur, the Sicilian producers giving an idea of the loss caused by this being conducted outside the island of Sicily.

NEW COMMERCIAL CONVENTION

A new commercial convention has been arranged with Poland for an exchange of products between the two countries despite the drastic exportation and importation prohibitions. The convention will continue in effect for six months. An agreement for nine months has also been arranged with Germany by which Italy will facilitate the importation of the following products: Synthetical essential oils and products, explosives, gelatine, coal-tar colors, colors for printing, colors for paints, articles of perfumery with and without alcohol, toilet soaps, lubricants and combustible mineral oils. Germany consents to the importation of lemon oil, orange oil, bergamont oil, lavender oil, peppermint oil, and other natural essential oils, citric acid, tartaric acid, oleic acid, liquid and solid tanning extracts, licorice extract, glycerine, talc, citrate of lime, pumice stone, raw boric acid, clove oil, seed oils, washed industrial olive oil and sulphide green olive oil.

ITALIAN ESSENTIAL OILS

The Agricultural Federation of Western Liguria has formed several organizations, among other places at Carpasio, Porto Maurizio, for the distillation of aromatic flowers and plants, and is encouraging the substitution of modern plants working with steam for the old Arab apparatus of the Middle Ages using direct fire. The federation is also encouraging the cultivation of aromatic plants. Fields have been placed at its disposal at San Remo, on the Riviera, where experimental cultivation will be carried on. At Porto Maurizio capitalists are projecting the establishment of a large plant for the extraction of the essence of roses and other flowers and plants to produce natural perfumes and aromatic products. During 1920 Italy exported 2,539 tons of fresh flowers, in 1919 2,109 tons and in 1918 1,163 tons.

ITALIAN MANNA PRODUCTION

Italy is the only country in the world where the manna plant is utilized for medicinal purposes, although it grows as a tree also in other portions of Europe and in America. Castelbuono, in Sicily, is the principal center of the manna tree cultivation, nearly two-thirds of the entire Italian production being collected there. For this reason there has been established at Castelbuono an experimental station for the growing of the manna tree. The cultivation of some new species will be essayed and the various species of manna will be classified according to their botanical origin and their physical characteristics. Their employment in the different industries will be studied and an attempt will be made to intensify their use in pharmacy. Their therapeutic effects will be closely studied in relation to other pharmaceutical products of analogous properties of nature. Besides this, the chemicai characteristics of the various adulterations will be investigated, as well as control of prices.

ELECTRIC RAILWAYS IN ITALY

The general director of state railways has proposed to the Italian Government that Germany be made to deliver, on account of war reparation, a certain quantity of electrical materials, not obtained quickly enough in Italy itself, for the electrification of the most urgently needed electric lines. It has been proposed to electrify the Pisa-Leghorn and Brennero-Verona-Bologna lines and those in the Istrian peninsula and Trento district. Express service is also being considered between Rome and Naples. Projects are also being studied for the electrification of the Naples-Reggio-Calabria and Paola-Cosena lines. For this vast system of electrification 90,000,000 lire has already been obtained.

ITALIAN PRODUCTION OF MINERALS

The quantities in tons of ores mined in Italy during the past year were: Iron, 473,000; manganese, 29,140; copper, 6,360; lead, 34,425; zinc, 73,180; silver, 500; antimony, 125; iron pyrites, 316,500; iron-copper pyrites, 4,400; and metallic mercury, 855.

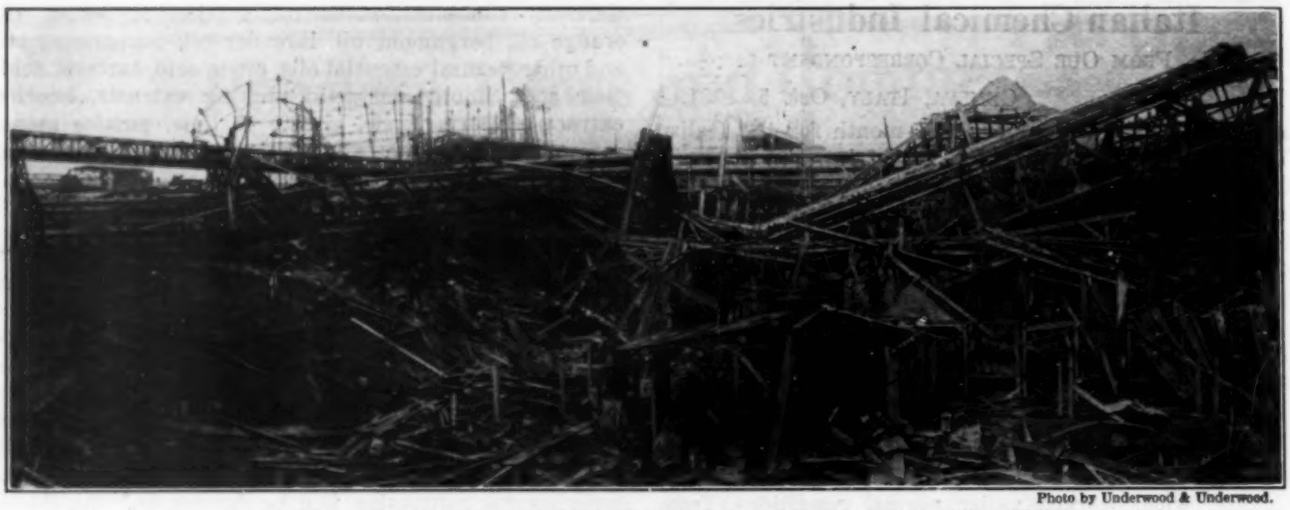

Photo by Underwood & Underwood.

A PARTIAL VIEW OF THE WRECKAGE CAUSED BY THE OPPAU EXPLOSION

The Explosion of the Nitrate Plant at Oppau

Some Interesting Comments on the Disastrous Effects and the Possible Causes of the Fatal Explosion at the Plant of the Badische Anilin und Soda Fabrik at Oppau, Germany, on Sept. 21, 1921

UNUSUAL interest attaches to the serious explosion which wrecked a large part of the extensive chemical works at Oppau, Germany, caused much damage to the surrounding country and was responsible for the deaths of hundreds of employees. Although a number of theoretical explanations have been proposed, the fact remains that little is known, or probably ever will be known, regarding the true origin of the explosion. In the following pages, however, there is presented an interesting report of a German chemist and engineer who was in the region at the time and later inspected the scene of the disaster. There are also included a number of unusual photographs, which when carefully studied in connection with the accompanying map, clearly reveal the extent and nature of the damage caused by the explosion.

First-Hand Impressions of the Oppau Disaster

BY DR. ING. CARL COMMENTZ

It was the privilege of the writer to inspect the Oppau plant of the Badische Anilin und Soda Fabrik on Sept. 29, 1921, or a little more than a week after the fatal explosion which so completely destroyed this important center of German chemical industry. Words cannot picture the extent of this destruction and even the photographs which accompany this article give but a limited conception of the almost inconceivable wreckage caused by the sudden explosion of about 4,500 tons of the practically unknown chemical fertilizer ammonium sulphonitrate. The explosion itself is a mystery and very probably will remain so, for apparently no one was aware of any unusual danger incident to the manufacture and storage of this chemical product.

THE STORY OF THE EXPLOSION

The story of the terrible disaster is a very short one. At 7:29 and again at 7:32 in the morning of Sept. 21, there occurred two terrific explosions in the northern part of the plant, which is devoted to the production of ammonium nitrate and other salts. The large buildings containing the ammonium sulphonitrate disappeared entirely and nothing was left in their place except a mammoth crater 250 ft. in diameter and more than 50 ft. in depth. This crater filled with water immediately after the explosion, so that its apparent depth is somewhat deceiving. (See Figs 1 and 2.)

No one of the workmen in or near this part of the plant escaped and there is none left to give an account of what immediately preceded the explosion. In all 430 lives were lost and included in this number are over 200 whose bodies had not been recovered even after a week of diligent search. General work had not yet begun at the time of the explosion and of the 7,000 employees only about 2,225 were at the works.

The village of Oppau, surrounding the plant on three sides and inhabited mostly by its workmen, suffered great damage. Over 70 per cent of the thousand dwell-

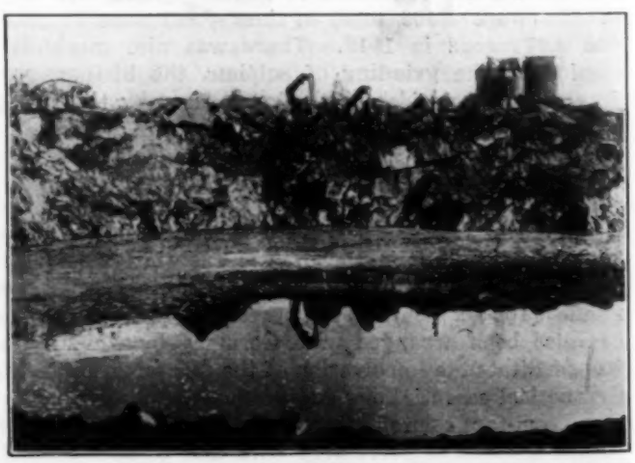

FIG. 1. A VIEW FROM THE EDGE OF THE CRATER CAUSED BY THE EXPLOSION

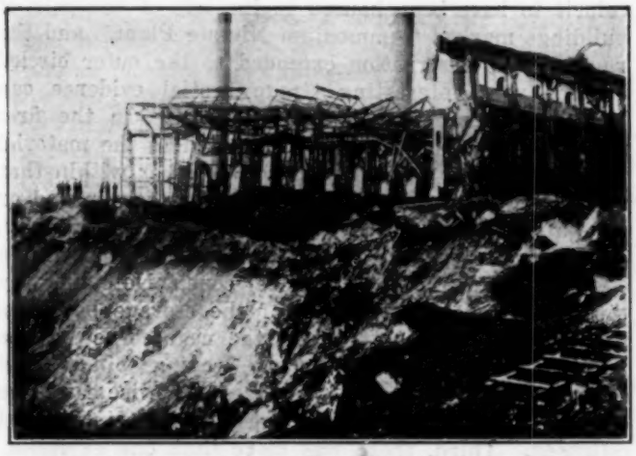

FIG. 2. LOOKING SOUTHEAST FROM THE SCENE OF THE EXPLOSION. THE WALL STANDING AT THE RIGHT IS THAT OF ONE OF THE TWO STORAGE HOUSES

ings were either totally or partly wrecked. Most of the houses were occupied at the time and the fact that the loss of life in the village was comparatively small (only fifty were killed) is perhaps explained by the fact that in many cases the walls and roofs were sucked away rather than falling in or down upon the occupants. The damage to property in Oppau has been estimated at 175,000,000 marks.

Effects on Neighboring Districts

Houses in the adjacent city of Ludwigshaven and in Mannheim, which lies opposite to Ludwigshaven on the right bank of the Rhine, were damaged, walls were shaken down and practically all windows were broken. At these places and at Heidelberg, which is about fourteen miles from Oppau, the effect of the explosion was first felt by two very heavy earthquake-like shocks. In Mannheim some seconds later and in Heidelberg 82 seconds after the shocks there came an enormous rush of air which broke windows and doors and caused damage to gas holders, oil tanks, and many river barges. The sound of the explosion and the earth shocks reached as far as Bayreuth, at a distance of 145 miles, and the air pressure wave caused considerable damage in Frankfurt, which is about 53 miles from the scene of the explosion.

FIG. 3. DAMAGED BUILDING NEAR THE EXPLOSION

The process for the manufacture of the different salts from the synthetic ammonia was in operation before the outbreak of the war and two types of mixed salts were known—viz., the so-called "ammonsulfatsalpeter" ($(NH_4)_2SO_4.NH_4NO_3$) and the "kaliammonsalpeter" ($K_2SO_4.NH_4NO_3$). Although the former was the cause of the explosion, its production, handling and storing had never been regarded with suspicion, nor had it ever shown evidence of spontaneous ignition. Indeed, when stored in large quantities it forms itself into a hard, rocky mass and it has been common practice to blast the material with dynamite in order to prepare it for transportation.

Theories Regarding the Origin of the Explosion

No one will ever be able to give the exact cause of the explosion, but some facts which may have an important bearing on the subject were brought out in a recent discussion of the affair in the German Reichstag.

FIG. 4. A STREET IN THE VILLAGE OF OPPAU

It was said that the company intended to blast the material on a much larger scale in the near future, but it was not proved that this change had been put into effect. In past years about 16,000 blastings of the salt had been made with dynamite without any mishaps. Another cause which was spoken of is the reported explosion of a gas engine which gave a shock severe enough to detonate the large mass of mixed salt. It was also recorded that prior to the explosion the color of the salt was known to have changed from its usual pure white color to a slightly yellow color; and that the temperature in the storehouse had risen to 100 to 120 deg. F. during the night preceding the explosion. This would appear to strengthen the suspicion that by some sort of a decomposition there had been a spontaneous ignition of the mass.

Experiments With the Mixed Salt

The director of the Physikalisch Technische Reichsanstalt reported on experiments with ammonium sulphonitrate which had been made in his Institute directly after the catastrophe. A large number of unsuccessful attempts were made to explode this material, even with strong blasting dynamite cartridges such as are commonly used for mining purposes. However, using a very strong initial explosive and with the material packed into iron piping, the Institute succeeded in ex-

FIG. 5. DESTROYED HOUSES IN OPPAU

ploding a part but not all of the ammonium sulphonitrate. Fire and high temperatures appear to have no exploding effect on this salt. The director concluded that nothing could be deduced from the experiments which might be said to have caused the explosion.

The management of the Badische company has announced that the manufacture of the salt will be abandoned at once and the ammonia will be used for the production of ammonium sulphate. The part of the plant in which the synthesis of ammonia was carried out is nearly intact and will require practically no rebuilding.

Ludwigshaven, Germany.

Evidence From the Photographs

EDITORIAL COMMENT

Several excellent photographs of the damage done by the Oppau explosion have now reached America. Some of them have been published in the newspapers, mostly using as subjects demolished residences in the town itself. The latter are of little technical interest, except that they bear evidence that much of the damage was done by violent expansion of the air within the dwelling, throwing debris into the streets and yards. This is a characteristic type of damage observed in the vicinity of heavy explosions. That the walls burst outward rather than collapsed inward is doubtless the reason the loss of life in the town was not far greater.

All trustworthy reports of the disaster agree that the damage was so extensive and violent that it could not possibly have been caused by anything but a large amount of solid or liquid explosive. It perhaps requires no argument to discredit early newspaper reports of a gas explosion; the airplane view in Fig. 7 shows a crater that would be expected from no less than thousands of tons of TNT. Comparison of this photograph with the map reproduced in Fig. 6 shows the culprit to have been housed in the left of the pair of buildings marked "Ammonium Nitrate Plant," and the range of its destruction extended to the outer circle.[1]

Some very interesting circumstantial evidence can be drawn from these two illustrations. In the first place, no disastrous explosion occurred in the material in the buildings marked "Storage"—either within that set of four long walls in the immediate foreground or the pair of arch roofed warehouses three tiers away. Second, the crater was excavated by a shock whose main effect was expended in a vertical cone. Note the way the upper ends of the walls of the storage buildings are trimmed off, also the way the near corner of the building at the left is shot away, leaving spindly steel columns standing near by. No great sidewise earth jar occurred, else the four tall smokestacks certainly would collapsed. Third, there was more than one explosion. Note a small crater between the large one and the railroad grade to the right, where once a small unnamed building stood. A ragged trench appears to extend forward from the sulphuric acid concentrators, perhaps toward the narrow building shown in the extreme lower right hand corner of the map. If this is the result of a train of explosives, it may account for the total demolition, except for the foundations, of the building alongside. Protected as it was by the railroad embankment, it should not have been so completely razed by the main blast. Furthermore, a building

[1]This map is adapted from that appearing in CHEM & MET. ENG., vol. 24, p. 394, March 2, 1921, and was derived in the first instance from an article, bearing all the earmarks of authenticity, in *La Technique Moderne*, November, 1920.

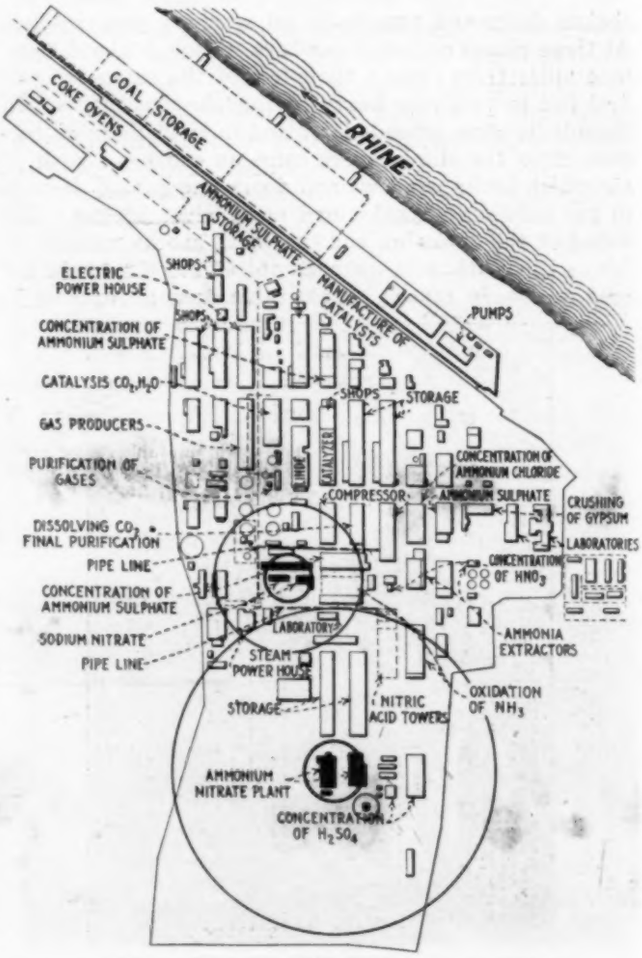

FIG. 6. MAP OF THE WORKS AT OPPAU

devoted to the oxidation of ammonia at the extreme right border appears to have been demolished, possibly from an internal explosion, since nitric acid towers and pipe and conveyor trestles immediately alongside appear relatively unhurt. But most striking of all is the disappearance of buildings in the central portion of the area, marked in black on the map, and supposed to house apparatus for working up sodium nitrate. The fact that nitric acid at Oppau was made by the oxidation of synthetic ammonia makes it at least doubtful if sodium nitrate was being used or stored. It might even be possible that these buildings were being used as storage for ammonium nitrate. At any rate a relatively small space appears to have been swept clean by a blast which also went up, rather than sidewise, as can be inferred from the condition of neighboring pipe lines, conveyor galleries and gas-holders, and the litter of collapsed steel and wood immediately alongside to the right, shown in the photograph at the top of page 818.

Were the Ammonia Catalyzers Responsible?

On the basis that the published map of the works is approximately correct, reasonable surmises as to the nature of the explosive are not forthcoming. Evidently gas could not do it. Nor would one expect that the amount of material in process, even in so large a plant as Oppau, if detonated could cause more than local damage. Yet the pictorial evidence is overwhelming in showing that the known storage buildings were not the seat of any explosions.

In view of the oft-repeated statement that ammonia catalyzers or converters burst at practically the same time as the main explosion, Prof. R. S. Tour of the University of Cincinnati expresses the opinion that this could have detonated large piles of "mischsaltz" in the vicinity. He thinks that it may have been caused by the practice of injecting air into the synthetic ammonia converters for starting or to maintain temperature. The men at Oppau themselves realized that this was a dangerous practice, and made various attempts to develop operation so that this step could be avoided. Could this account for the isolated areas where excessive damage can be observed? The catalyzer building is so far from the observer in Fig. 7 that it is impossible to judge whether there was unusual destruction at that point—the front wall is gone, although the roof seems to be unharmed. Even though some of the catalyzers exploded, why should this have detonated material several hundred feet away? We are advised that explosions are caused by heat, rather than shock. And yet intermediate areas are covered with broken timbers—in fact, one of the peculiar things about the disaster is that it was not followed by fire.

One may object that the main crater cannot be explained by the bursting of chemical apparatus holding less than thousands of tons of the most violent explosive. On the other hand, neither ammonium nitrate nor the mixed salts (ammonium sulphate-ammonium nitrate) are usually regarded as explosive. Pure nitrate must be highly compressed and slightly heated before it can be detonated by a blasting cap. The commercial

Photo by Underwood & Underwood.

FIG. 7. AIRPLANE VIEW OF OPPAU PLANT OF BADISCHE ANILIN UND SODA FABRIK TAKEN AFTER THE DISASTER

salt cakes very easily, and it has been common practice to break large masses by dynamite when necessary to move it. Consequently it is fairly insensible to detonation. Intimately mixed with nitroglycerine, powdered aluminum or TNT, it was used extensively during the war as a high explosive, the two latter being commonly known as amonal and amatol. By the effects, one is tempted to suppose that it was some cellars full of this stuff which let go or perhaps even some forgotten mines prepared for the day when the Allied troops would appear along the Rhine!

Spontaneous Decomposition of the Mixed Salts

Dr. Ing. E. Hene of Stassfurt, in the Oct. 6 issue of *Chemiker-Zeitung*, suggests a gradual decomposition of the ammonium nitrate-ammonium sulphate mixture which might have caused the initial detonation of the Oppau explosion.

A possibility is suggested by the fact that one of the mixed salts—e.g., the sulphate—might have an acid reaction. The free sulphuric acid would liberate nitric acid from the ammonium nitrate, and this acid could react in various ways with the ammonium salts. For example, the following reactions are known:

(1). $6HNO_3 + 5(NH_4)_2SO_4 = 18H_2O + 8N_2 + 5H_2SO_4 + 536$ cal.
(2). $2HNO_3 = 2NO_2 + O + H_2O$.
(3). $N_2O_3 + (NH_4)_2SO_4 = H_2SO_4 + 3H_2O + 2N_2 + 138$ cal.

It will be noted that in reaction 1 only 3 molecules of H_2SO_4 are required to produce the 6 molecules of HNO_3 which react to regenerate not 3 but 5 molecules of H_2SO_4. Furthermore, reactions 1 and 3 are exothermic. Hence under favorable circumstances it is possible for a small initial amount of free H_2SO_4 to produce a gradual increase of temperature and of acidity, thereby hastening the decomposition and eventually leading to detonation and explosion. Although the conditions may not seem to be favorable for reactions 1 and 3, it is possible that the pressure in the interior of storage piles, combined with the fact that the heat of reaction cannot be dissipated readily, may influence the reactions.

If these surmises are correct, it would seem that the addition of an alkali such as ammonium carbonate would be advisable. Large storage piles should be avoided and the piles should be turned over from time to time in order to prevent local overheating.

Production of Iron and Steel in Italy

The iron and steel industry in Italy, which succeeded in establishing itself in the pre-war period, reached its maximum activity during the war, but it has since rapidly declined, and it has suffered perhaps more than any other Italian industry from the present crisis. The principal cause of the difficulties encountered by the Italian industry lies in the high cost of fuel. In 1919, and still more in 1920, Italian iron and steel were produced at a cost 500 lire per ton in excess of the cost of foreign competitive products; and while the Italian industry was in this unfavorable condition, the home market was completely and freely open to importations from abroad, reports Consul General Osborne of Genoa in *Commerce Reports*.

Data in regard to the production, importation, exportation and apparent consumption of ore, pig iron, and finished iron and steel follow:

PRODUCTION, IMPORTS, EXPORTS, AND CONSUMPTION

Years	Production Tons	Imports Tons	Exports Tons	Amount for Consumption Tons
Iron and Manganese Iron Ores				
1913	603,116	8,026	9,660	601,482
1914	706,246	4,592	8,944	701,894
1915	679,970	7,607	157	687,420
1916	946,604	739	30	947,313
1917	998,632	313	327	998,618
1918	694,677	1,951	66	696,562
1919	465,655	12,533	1,679	476,509
1920	423,300	1,607	5,786	419,121
Pig Iron				
1913	426,754	240,039	1,809	664,984
1914	385,340	237,178	1,250	621,268
1915	377,510	247,301	1,401	623,410
1916	467,005	305,550	974	771,581
1917	471,188	319,967	433	790,722
1918	313,576	119,606	301	432,881
1919	239,710	223,811	441	463,080
1920	*	165,070	42	*
Iron and Steel				
1913	933,500	277,255	28,116	1,182,639
1914	911,000	244,816	14,107	1,141,709
1915	1,009,240	226,156	133,073	1,102,323
1916	1,269,486	317,862	31,840	1,555,508
1917	1,931,641	192,410	23,341	2,100,710
1918	992,529	656,668	2,700	1,646,497
1919	731,823	465,731	6,354	1,191,200
1920	*	269,846	1,311	*

* Figures not available.

The amount of iron ore existing in Italy is estimated at about 40,000,000 tons and is irregularly distributed. The most important mines are those of Elba (up to now actively exploited), those of Cogne in Piedmont and those of Nurri in Sardinia.

Table of Statistics of Canadian Chemical and Allied Industries*

Industry	No. Plants 1918	No. Plants 1919	Capital Invested Includes Value of Lands, Building Machinery, Materials on Hand and Bills Receivable 1918	Capital Invested Includes Value of Lands, Building Machinery, Materials on Hand and Bills Receivable 1919	Cost of Materials Used 1918	Cost of Materials Used 1919	Value of Products Made 1918	Value of Products Made 1919
Ammonia	3	3	$432,440	$511,414	$205,195	$129,478	$409,437	$331,581
Boiler compounds	4	6	176,789	144,994	55,660	70,305	137,076	188,144
Drugs and chemicals	36	34	20,550,661	13,495,257	11,995,916	1,957,683	20,670,178	5,090,338
Disinfectants	7	6	67,942	115,324	44,760	52,427	116,083	154,138
Dyes and colors	3	4	194,917	245,642	135,191	156,870	222,882	279,542
Explosives	11	8	19,172,539	12,840,037	23,025,839	2,017,306	45,402,892	4,495,609
Fertilizers	15	15	3,064,111	3,331,403	1,573,582	1,289,785	2,562,688	2,249,621
Gas, illuminating and fuel	38	38	26,937,885	26,972,854	3,456,396	4,046,563	7,282,147	7,213,544
Glass	11	13	7,443,525	7,231,774	2,056,739	2,267,686	6,662,116	7,171,006
Glue	11	13	1,562,086	1,620,433	812,923	748,051	1,488,147	1,510,112
Gold refining†	4	....	840,917	....	3,133,073	....	4,331,010	....
Ink	14	16	1,022,089	1,234,672	876,672	969,595	1,746,935	2,019,037
Leather	139	113	28,435,806	34,599,542	23,681,659	34,283,896	35,357,450	46,996,298
Liquors, distilled	6	5	10,018,168	8,154,002	2,271,178	724,268	2,883,115	1,288,477
Liquors, malt	63	57	32,433,507	28,119,477	6,543,058	8,093,403	16,370,946	20,169,074
Matches	3	4	2,301,622	2,493,997	771,077	1,076,788	1,545,680	2,207,221
Oils	19	18	4,493,292	3,925,103	5,759,895	7,908,060	7,080,512	9,768,699
Compressed gases	14	16	1,736,913	1,824,911	89,042	133,821	1,063,771	1,172,778
Paints and varnishes	45	44	15,784,610	17,830,072	9,203,530	10,835,474	17,796,518	19,506,653
Patent medicines, etc	125	123	9,434,904	11,167,869	5,549,532	5,872,989	13,487,905	13,671,350
Soap	28	26	13,086,933	12,017,281	14,595,624	12,070,181	20,944,909	17,384,260
Starch and glucose	12	7	3,784,664	6,332,658	4,992,705	5,709,203	7,788,742	7,953,273
Sugar	8	8	37,256,851	38,725,542	45,403,037	86,308,204	58,812,219	102,630,086
Tallow	5	5	79,117	77,251	61,933	70,762	93,627	127,053
Wood distillation	13	13	3,612,573	5,760,395	3,319,731	1,173,473	7,634,122	2,812,037
Petroleum	10	10	35,745,410	43,158,655	24,454,575	26,264,839	37,866,907	43,256,317
Miscellaneous	18	30	14,426,783	19,741,875	2,731,486	3,813,190	9,644,632	13,408,391
Total	663	630	$294,097,054	$301,672,404	$196,799,978	$218,044,300	$329,492,636	$332,964,639

* From *Canadian Chemistry and Metallurgy*.
† Included with Metallurgical Works in 1919.

Silicate of Soda in Papermaking

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SILICATE of soda is a material which finds application in a great many branches of industry. Probably no heavy chemical has a wider range of uses. In its diversified application it has touched the experience of almost every one. Most papermakers are aware that it is used in the manufacture of paper and that it is added to the beater and precipitated with alum in the same manner as rosin size is precipitated, but only a small number know definitely the properties which its use imparts to paper. Some confusion is found also as to the respective functions of silicate of soda and rosin size in paper. Rosin size is necessary to give water resistance, but, as has been pointed out by Klemm[1] and others, resistance to printers' ink is produced with silicate of soda. A good deal of work has been done in the laboratory to show the nature of the precipitate which is formed from silicate of soda and the conditions under which this precipitate separates from the water in the beater and is retained among the fibers of the paper, modifying the character of the finished sheet.

The observations which are to be reported here are based also on practical experience with large quantities of paper. These have led to a better understanding of the behavior of silicate of soda in the beater and on the paper machine and have given a basis for better judgment of the conditions for its successful use.

NATURE OF SODIUM SILICATE

Before considering details of handling silicate of soda, it is necessary to make plain what we mean by this term. Silicate of soda is not the name of a definite salt, but rather the general name for an indefinite number of products composed of silica and soda in varying proportions. Different ratios of silica and soda, along with different concentrations of the solutions, give varying properties, both chemical and physical. It is this ability to modify the properties of silicate of soda which accounts for its great variety of uses. Adhesives, plastic cements, quick setting cements, sizings, gels, water softeners, detergents, paints and cements for digester lining are all included in its scope of usefulness. As drawn from the furnace, silicate of soda looks like glass. Like glass, the proportions of its ingredients may be varied within wide limits without much change in appearance. It differs from glass in that it may be dissolved in water. It comes upon the market in concentrated solutions. Much misunderstanding of results harks back to the assumption that silicate of soda is a definite thing, and many published articles report results which it is impossible to confirm or disprove without knowing just what grade of silicate of soda was used. Because two samples of silicate of soda look alike it does not follow that they are alike. Solutions ranging from 34 to 54 per cent total solids may have identical viscosity. The body of silicate is no index to the amount of solids present. To avoid confusion all manufacturers have established certain brands which represent definite compositions of silicate.

PRECIPITATION WITH ALUM

To precipitate silicate of soda in paper stock the soda is neutralized with alum. Hence a silicate with the smallest possible amount of soda should be chosen for reasons of economy. The lowest alkalinity which is practical from a commercial viewpoint is represented by a solution containing 7 per cent total alkali as Na_2O and a ratio of soda to silicate approximating 1 to 4. A product of lower relative alkalinity is too nearly insoluble to be of commercial use. Failure to neutralize the soda completely will result in an imperfect precipitation on the one hand and injury to the rosin sizing of the paper on the other. A silicate of 1 to 2 ratio requires twice as much alum to produce a given effect on the paper.

A solution of the 1 to 4 ratio is a jelly at 37 deg. Bé. corresponding to 34 per cent total solids. When this is diluted to the concentration corresponding to that which obtains in the beater and a solution of alum is slowly added, the solution becomes more and more turbid until it becomes acid in reaction and a precipitate separates from the solution. Other precipitating agents, such as niter cake, calcium sulphate or even hard water, will precipitate silicate of soda, and when these are used the amount of alum added for the silicate can be proportionately reduced. This is a large factor in some mills. The precipitate is very bulky and light and readily becomes entangled with the fibers, assisting in their retention on the wire and cementing them together. If an insufficient amount of alum be added, no precipitation will occur and without precipitation the advantage of using silicate is lost. It is, therefore, of first importance to see that a sufficient amount of alum is used to give an acid reaction. The precipitate contains the elements of an aluminum silicate. It probably contains along with the aluminum silicate both aluminum hydroxide and hydrated silica. Silicate of soda thus differs from rosin size, which begins to precipitate when the first small quantity of alum is added.

TEXTURE DEPENDS ON DILUTION

The texture of a silicate precipitate depends on the dilution of the silicate and the alum. Under the conditions occurring in the beater a light flocculent product, well adapted to harden and increase the strength of the paper, is produced, but if the chemicals were mixed in relatively concentrated condition the material thrown out would be granular, sandy or lumpy, just as would be the case if dry alum were mixed with a strong solution of rosin size. When the light flocculent precipitate is dried, it hardens to a horny consistency, too hard to be crushed easily by the hand. In this hard condition it still retains a considerable amount of water, which contributes largely to its toughness. The apparently dry precipitate always contains at least 25 per cent of water under the conditions of drying paper.

RETENTION AFFECTED BY CONCENTRATION

The effect of retaining this material in the substance of paper is shown first of all by an increase in the ash of the paper. A study involving 550 tons of paper and an examination of 1,200 samples gave an average of 1 per cent in ash with an average addition of 3.48 per cent of liquid silicate based on dry fiber. The amount of dry alum necessary for the precipitation of the silicate was 25 per cent of the weight of the silicate solution. The average retention was 66 per cent of the total silica in the silicate, plus the Al_2O_3 of the alum. There is good reason to suppose that the use of larger proportions of silicate, as reported by Blasweiler,[2] would

[1] Klemm, Mineralische Leimung von Druckpaper. *Wochbl. Papierfabr.*, 1907, No. 25, p. 1983.

[2] *Papierfabrikant*, 1921, vol. 33, p. 875.

not only produce more marked effects on the paper but would be accompanied by a higher percentage retention. Amounts as high as 10 per cent of the dry fiber will make the stock appreciably slower on the wire, but this effect was not observed at 5 per cent or less.

Strength and Ink Tests of Paper

The hardness and the finish of the paper were determined by the combined judgment of several experienced papermakers, as we know of no method of reducing these qualities to a numerical standard. From comparison of sheets, which differed only by the silicate content and the alum requisite for its precipitation, the statement is warranted that the use of silicate in every case produced a harder and a smoother sheet. The Mullen tests of the papers in this series when averaged show a gain of 12 per cent in favor of the papers containing silicate. Ink resistance was studied in four different grades of paper by the floating method with standard ink. In three of these grades the papers containing silicate showed better ink resistance than those which contained none. This may be attributed to the increased retention of rosin in the paper, there being no reason to believe that sodium silicate can of itself increase the resistance of paper to water or to an aqueous ink.

In studying the effect of the addition of silicate to the beater, it was observed that the increment of ash increased over a period of several hours, sometimes reaching its maximum as late as 7 hours after stock containing silicate came on the machine. This is interpreted to mean that a larger precipitation of the silicate and better retention develops as the white waters from which the silicate has been precipitated are returned to the machine and to the beaters.

Effects on Colors

Silicate, like rosin size, should be handled in such a way that its alkalinity does not affect adversely the colors used in the paper. Where the silicate is added first and is completely precipitated with alum before the addition of the color, no interference with the color has ever been experienced, but it is not safe to add the necessary quantity of alum and then a color sensitive to alkali before the silicate, because when the silicate is added it is certain to be for a short time locally in excess, and the full strength of some coloring materials is not restored by the alum. Owing to better retention some papers show an improvement in color when silicate is used and when handled with proper regard to its alkaline character, satisfactory coloring is always practicable in papers containing silicate.

From the point of view of maximum retention, the experiments point to the following order of additions to the beater as the most satisfactory: (1) Silicate, (2) alum for the silicate, (3) rosin size, (4) clay or other fillers, and (5) alum for the rosin size. Many variations are possible without destroying the effect of the silicate, this being simply the preferred practice.

Papers Treated With Silicate

The grades of paper which have been considered in careful tests include cover, envelope, papeterie, book, writing, kraft, tissue and boxboard. It would not be reasonable to say that silicate of soda should be used in every mill or even in every mill that requires the properties in paper which the use of silicate tends to impart, but it has been found possible in some cases to make a paper of acceptable quality with a less expensive furnish and in other cases to get a grade of hardness and finish not otherwise obtainable. In mills where the trim from combining machines using silicate as an adhesive is furnished to the beaters the resulting paper may be improved by precipitating the silicate with alum. Silicate of soda is always helpful in bristol boards, because of the cementing action on the fibers which tend to stand up as a fuzz or beard on the surface. This characteristic is also very useful in certain kinds of wrapping paper and the cheaper grades of writing paper. All paper that is judged by its rattle and snap can be improved by the judicious use of silicate.

Silicate-Starch Good Sizing Agent

As pointed out by Wrede,[3] papers intended for printing may be sized with silicate of soda or with silicate and starch in such a way as to provide all the qualities required in printing and with the added advantage that they are not subject to discoloration on long exposure to light, as are all papers which have been sized with rosin size. Printing ink is an oily substance and it is possible to produce a paper which gives perfect satisfaction in offset printing without showing much resistance to water. The more general recognition of a distinction between water resistance and oil resistance will do much to extend the usefulness of silicate of soda in the paper industry.

Belgian Industry Statistics

The table given below shows the production of the various branches of Belgian industry during 1920. These statistics were estimated at the Ministry of Economic Affairs and were obtained from production figures and average prices:

PRODUCTION OF CERTAIN BRANCHES OF BELGIAN INDUSTRY IN 1920

Industry	Production Metric Tons	Value Francs
Mines:		
Coal	22,413,535	2,016,000,000
Coke	1,801,280	180,000,000
Briquets	2,923,363	321,500,000
Quarries:		
Marble, building stone, flux, paving stone, sand	.....	231,000,000
Cement	648,147	95,600,000
Metallurgy:		
Pig iron	1,128,518	564,259,000
Zinc	82,960	149,000,000
Copper	4,850	25,000,000
Finished steel	1,071,856	810,000,000
Finished iron	197,032	170,000,000
Mechanical construction figures unobtainable.		
Glass:		
Plate glass	*2,419,315	109,000,000
Window glass	*26,449,583	300,000,000
Flint-glass industry	.....	96,000,000
Chemistry:		
Soda, potash, chloride of lime, calcium chloride, etc	.....	38,152,000
Sulphuric acid, hydrochloric acid, nitric acid, sodium sulphate, superphosphates	.....	183,925,000
Soap	.....	18,000,000
Matches	.....	11,500,000
Byproducts of coal—		
Akali	894	
Anhydrous ammoniac	62	
Ammoniac sulphate	9,048	
Benzene	4,194	
Dissolvent	759	
"Brai" (rosin, pitch, tar)	25,872	57,182,000
Naphthalene	4,702	
Creosote	5,543	
Tar	28,304	
Light oils	1,785	
Powder and explosives	2,200	10,000,000
Textiles:		
Cotton spinning	29,750	1,192,000,000
Flax	21,900	400,000,000
Wool (prepared)	20,618	400,000,000
Artificial silk	1,890	113,500,000
Weaving (insufficient information for estimating value).		
Paper and cardboard	106,097	180,000,000

* Square meters.

[3] Wrede, *Wochbl. Papierfabr.*, 1913, vol. 10, p. 835.

Radium Production in America—I

Grinding—Dissolving—Filtering—Crystallization—Conversion of Chloride Into Bromide—Tubing of Radium Bromide—Recovery of Vanadium and Uranium—Recovery of Radium From the Gelatinous Silica Press Cake

By H. D. d'AGUIAR

THE American radium-bearing ores are the carnotites found chiefly in the Paradox Valley of Colorado, deposited on and impregnating a fine grained, porous sandstone.

The carnotite, which is potassium uranium vanadate, is a bright canary-yellow crystal when pure, but the ore, as found, has usually the appearance of a dirty, mud-colored sandstone. The ores usually run from 1.5 to 2.8 per cent uranium oxide, though occasionally pockets containing ores running 10 and even 18 per cent uranium oxide are found. The higher grade ores are readily distinguished from the low-grade ones by their color, which becomes more and more yellowish as the values increase.

As radium is a product of the disintegration of uranium and as the amount of radium present is always in fixed proportion to the amount of uranium present, the percentage of uranium is an index of the milligrams of radium contained.

The ore occurs in pockets and though the actual mining difficulties may be few, the location of the deposits far from railroads, in a country where even wagon roads are next to impossible, together with the shortage of water, makes the mining operation difficult enough. The ore as mined is sacked and transported by burros to the camp, where it is weighed and assayed for uranium content by means of the alpha ray electroscope. The bags are then marked with lot numbers and shipped to the reduction works.

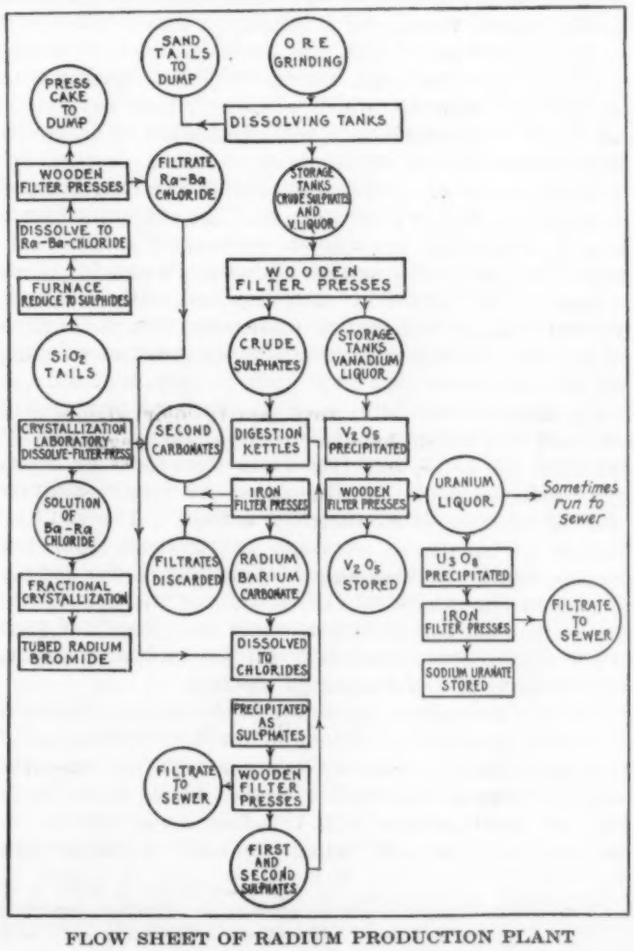
Grinding and Dissolving

On arrival at the reduction works the various lots of ore are weighed and stored separately in a dry warehouse. The action of water on the ore alters the uranium: radium ratio and would carry away much of the fine high-grade material; therefore it is important to keep the ore dry.

From the warehouse the ore is sent to the grinding mills, where it is reduced by means of Hardinge or other suitable ball mills to pass 60 mesh. The lots are either run through the mills separately or lots of about the same values are combined into one large lot.

Two samples of the ground ore are taken. One is sent to the analytical laboratory for determination of uranium oxide, vanadium oxide, barium and calcium oxides and moisture. The other sample is sent to the electroscopic laboratory, where the percentage of uranium present is determined by radio-activity with the alpha ray electroscope. The results obtained by the two laboratories on uranium should check closely.

The analyzed ore is sent to the dissolving tanks. These tanks are acid-proof and good service is given by tanks constructed of acid-proof brick. The tanks are shallow and about 60 sq.ft. in area. The ore is spread in a layer from 4 to 6 in. deep on the bottom of the tanks and is then wet down carefully with water or weak vanadium-uranium liquor from previous extractions. So prepared, the ore is ready for the extraction of the uranium, vanadium and radium. This is accomplished by treating the ore with the amount of hydrochloric acid necessary to dissolve all values as computed from the chemical analysis and the number of pounds of ore placed in the tank. During the addition of the hydrochloric acid the ore is continually turned and agitated so that the acid may act evenly on the entire mass. Sulphuric acid is then added in sufficient quantity to precipitate all barium and calcium. Water or more weak vanadium liquor from previous extractions is then added. The stirring is continued throughout the entire operation. The liquor, which now contains the uranium and vanadium in solution and the barium-radium sulphate in suspension, is removed by decantation through an opening in the side of the tank at a height flush with the top of the bed of sand tails. The bed of sand remaining in the tank is washed with water or more weak



FLOW SHEET OF RADIUM PRODUCTION PLANT

vanadium liquor and is again stirred to remove any sulphates. The liquor first decanted and the first wash waters go to a storage tank, while the succeeding wash waters, being weaker in radium values, go to a second storage tank. These weak liquors are used for first washes on new lots of ore, the sulphates accumulating in this tank being periodically cleaned up and combined with other lots of sulphates.

The sand tails before being conveyed to the dump are carefully sampled and a sample is sent to the electroscopic laboratory for analysis. The tails should show little or no activity. An activity equivalent to 0.05 per cent uranium oxide should be the maximum permissible, the determination being made immediately after drying and cooling.[1]

Filtering

The liquor and sulphates in the first storage tank are siphoned or pumped to a wooden frame filter press equipped with Duriron pumps. The vanadium-uranium liquor passing through as filtrate is pumped to storage tanks. The first wash waters from this operation are also pumped to this tank, while the remaining part of the wash water which shows vanadium is pumped to the storage tanks containing the last washes from the sand tails.

When the press cake has been washed, the press is stripped and the cake sampled and weighed. One portion of the sample is sent to the analytical laboratory for determination of moisture and barium sulphate. The other portion goes to the electroscopic laboratory, where the radium content is determined by means of the emanation electroscope.

These crude sulphates are transferred to pressure kettles, where water and a calculated excess of sodium carbonate are added and the mass is "cooked" under steam pressure until the barium sulphate together with the radium sulphate, which always follows barium, is converted to the carbonate with formation of an equivalent amount of sodium sulphate.

The contents of the pressure kettles are then pumped through iron frame filter presses. The sodium sulphate liquor, containing the excess unchanged sodium carbonate, is run to the sewer. However, a careful check is kept on this liquor by sampling frequently and having the samples analyzed to make sure that it contains no radium. A very minute activity is sometimes found, but as a rule these liquors contain no radium at all.

The frames and cloths used on the filter presses are carefully inspected to make sure that they fit perfectly and that the cloths are free from thin spots or holes. Any leakage would be the cause of losing radium-bearing material of considerable activity. The radium-barium carbonate so obtained is stripped from the presses, sampled and weighed. One-half of the sample is sent to the analytical laboratory for the determination of barium and moisture, while the other half goes to the electroscopic laboratory for determination of radium content by the emanation method.

The barium-radium carbonate so obtained is dissolved in a tank with dilute, sulphate-free hydrochloric acid. This acid chloride solution, together with the insoluble matter, is pumped through a wooden frame filter press. The filtrate, together with the first wash waters, is run to a storage tank, while the later, weaker, wash water is run to a second storage tank. The press cake, which is chiefly gelatinous silica, requires thorough washing to remove all possible soluble values. This cake is never washed free from radium values, so when the activity has been reduced to the minimum compatible with economical working of the plant, the cake is stripped, and when a sufficient quantity has accumulated the whole lot is reworked separately.

The chloride liquor in the first tank is treated with sulphuric acid to precipitate the barium-radium chloride present as the sulphate. Samples of the liquor are tested from time to time during the precipitation to insure an excess of sulphuric acid.

Treating the Wash Waters

At this time an excess of sulphuric acid is added to the second tank containing the wash waters. The small amounts of sulphates so precipitated are allowed to settle to the bottom of the tank. The bulk of the supernatant liquor is then decanted through a filter press having wooden frames. When the liquor has been drawn down close to the sulphates, they are stirred up and thus transferred to the press. The sulphates in the main tank are not allowed to settle, but pumping is commenced as soon as sulphation is completed. The filtrate and washings may be discarded. The sulphate cake when washed free from acid is stripped, sampled and weighed. Barium sulphate and moisture are determined in the analytical laboratory and the radium content in the electroscopic laboratory by the emanation method.[2]

These second sulphates are transferred to the pressure kettles, mixed with a calculated excess of sodium carbonate, and converted to carbonate by heating with steam under pressure in the same manner as before. When the conversion has been completed, steam is shut off and the carbonates and liquor are pumped through an iron frame filter press and washed with water until the washings are free from alkali. The washings are tested from time to time by the electroscopic laboratory to make certain that they are free from radium. When the wash water runs free from alkali, the carbonate cake is stripped, sampled and weighed. The radium content is determined by the electroscopic laboratory and the barium carbonate and moisture by the analytical laboratory.

If the foregoing operations have been properly conducted, the second carbonates will be of sufficient purity, of high activity, and suitable for delivery to the crystallizing laboratory.

Crystallization

The crystallization laboratory receives from the plant the weighed, analyzed carbonates. The laboratory is charged with the number of milligrams of radium contained in each lot of carbonates delivered. The efficiency of the extraction work is reckoned from the number of milligrams of radium in the ore treated divided into the number of milligrams in the carbonates delivered to the crystallization laboratory. The percentage so obtained will be raised somewhat by the radium recovered by reworking the press cake from the first carbonates.

The carbonates received from the plant are dissolved

[1] The process of extracting the values by means of nitric acid has been tried. Though perhaps a gram or so of radium has been produced by this method of extracting, it is needlessly expensive and has never met with much favor.

[2] For the precipitation of the sulphates a solution of sodium sulphate can be used to good advantage instead of sulphuric acid, providing the price of the sodium sulphate is low enough to make the cost of the sulphate radical contained as low as or lower than the cost of the sulphate radical in the sulphuric acid.

in dilute, sulphate-free hydrochloric acid. The acid solution of barium-radium chloride so obtained is filter pressed through a wooden frame press. The filtrate from the press goes to a system of large crystallizing pots. These pots may be either of acid-proof enamel ware or earthen ware. The cake in the filter press, again consisting chiefly of gelatinous silica, is washed thoroughly with sulphate-free water, the washings going to a special pot for concentration before being combined with the main portion of the filtrate. The press cake is stripped, sampled and analyzed for moisture and radium content. After weighing, the amount of radium contained can be computed. This cake is then returned to the plant for reworking, and the crystallizing laboratory is credited with the amount returned.

The volume of the chloride liquor obtained in dissolving the carbonates and washing the press cake is measured. A sample is then taken and sent to the electroscopic laboratory for determination of the radium content. The milligrams so found plus those found in the press cake should equal in amount the milligrams in the carbonates delivered to the laboratory.

Separation of Radium From Barium

Separation of the radium from the barium by fractional crystallization is started as soon as the chloride liquor has been sampled. This first liquor is concentrated by boiling until close to the saturation point. It is then allowed to cool. On cooling, crystals of radium-barium chloride will form. These crystals will be richer in radium in proportion to barium than was the original liquor. The mother liquor is removed from the crystals and its volume carefully measured. It is then sampled and the radium content is determined by the electroscopic laboratory. The crystals are dissolved in sulphate-free water and hydrochloric acid. The volume of this solution is also measured, a sample taken, and the amount of radium contained determined. The solution of the first fraction crystals is again crystallized, when there will be obtained another crop of crystals richer in radium in proportion to barium than were the first crystals. The first mother liquor is concentrated further, cooled, and another crop of crystals obtained which are weaker in radium than the first fraction, but richer in radium in proportion to barium than was the mother liquor from which they were obtained. These processes are repeated until the mother liquors are practically free from radium.

It is never possible in practice to get the mother liquors free from all traces of radium. The fractional crystallizing continually reduces the bulk of the crystals, with a corresponding increase in the amount of radium per pound of barium. When the bulk of the crystals is small enough they are transferred from the pots to a table, where the crystallization is carried on in large silica dishes. The procedure on the table is exactly the same as in the pots, the only difference being that a smaller volume is handled. As the purity increases with each fractionation, more and more care is required in handling the succeeding fractions, as the loss of a little liquor or a small amount of crystals with their high radium content is a serious matter.

Conversion of Chlorides Into Bromides

When the fractionation has proceeded to a point of sufficient purity, the fractions are delivered to the bromide table, where the chlorides are converted to bromides and the purification by fractional crystallization is continued. The bromide crystallizing is usually carried out in a separate room. Each fraction received from the chloride tables is carefully sampled and analyzed. The reason for duplicate determinations on these samples is to avoid even the temptation of theft as well as to supply an accurate record of the work in the two branches of the crystallizing laboratory.

The fractions as received by the bromide room, after sampling, are carefully carbonated with ammonium carbonate, which precipitates the radium and barium as carbonates. The carbonates are separated from the liquid by filtration through suction funnels. The carbonates on the filter are washed with dilute ammonium carbonate solution and then dissolved in hydrobromic acid. This original bromide solution is measured, sampled and analyzed as a check against losses in the conversion process. After sampling, the crystallization of the bromides is commenced. The crystals of each fraction and also the mother liquors of each fraction are sampled and analyzed. When the purity has been carried to a point where the crystals can be handled in small dishes of about 6-in. diameter, further fractionations are carried out in a water bath. The final fraction is carefully crystallized, the mother liquor is decanted from the crystals, and the crystals are carefully dried to remove all moisture. The radium bromide so obtained is immediately tubed.

Tubing of Radium Bromide

The tubing process is the transferring of the radium bromide to a small thin-walled glass tube by means of a small metal applicator. The tube is then sealed by drawing to a point in a small gas flame. The process must obviously be conducted where there are no air currents to carry away any of the dry radium bromide. The tube is preferably made of potash glass and is of a size selected to hold easily the amount of radium bromide ready for tubing. While transferring the bromide to the tube it is held with forceps and not with the fingers. It is perhaps easier to hold the tube in the fingers while filling, but this is done only at the risk of severely burning the fingers. A radium burn is by all means to be avoided as, unlike a burn from fire, it continues to attack the flesh and if at all severe even parts of the finger bones will be destroyed.

The different fractions obtained in the bromide crystallizations are preferably tubed separately so that a check on the crystallizing work may be kept. With a little practice a good operator can keep the bulk of the radium in the first two fractions, the succeeding fractions containing only a small percentage of the total amount. Carelessness will result in the radium scattering through all the fractions, resulting in needless work and loss of time.

The tubed radium from the bromide room is delivered to the electroscopic laboratory for estimation by means of the gamma ray electroscope. Tubed radium, of course, on account of its activity is never kept in the electroscopic laboratory, but in a safe or vault provided for the purpose and located some distance from the laboratory, the radium being taken in only for estimation and immediately returned. A reading is made on the tube as soon after its delivery by the crystallizing laboratory as possible so that the crystallizing laboratory may know the amount tubed in each fraction and be guided in their work. The first reading, made immediately after tubing, is never accepted as anything but approximate. Four days later a second reading is

made and recorded and the final reading is made after thirty days have elapsed since tubing, the radium then being in equilibrium with its emanation and the results accurate and final. The final readings on each tube are credited to the crystallization laboratory. The amount tubed divided by the amount delivered to the crystallization laboratory will give the percentage of recovery.

Recovery of Vanadium and Uranium

The vanadium-uranium liquors in the storage tanks, from which the sulphates have been removed, are allowed to collect until the tanks are nearly full. Sodium carbonate is added until the liquid is but slightly acid, then sodium nitrite is added, and the tank is heated to boiling by steam. If the liquid is but slightly acid at this time, the vanadium oxide, carrying some iron and uranium and considerable amounts of soda salts, will be precipitated. The precipitation is never complete, but if the acidity is checked by volumetric control tests during the process, a very good recovery is obtained. The precipitate will be granular in character and will filter readily. When the reaction has been completed, the vanadium oxide is separated by filter pressing. The cake is analyzed for moisture and vanadium oxide. A comparison of the vanadium oxide so precipitated with the amount in the ore treated will give the percentage of recovery. The vanadium oxide so precipitated finds a ready market with manufacturers of ferro-alloys.

If it is desired to recover the uranium oxide remaining in the filtrate from the precipitation of the vanadium oxide it is returned to tanks for the purpose and the uranium precipitated as sodium uranate by addition of sodium hydroxide until the liquor is alkaline. The sodium uranate so precipitated will carry the rest of the iron in the solution and also the major portion of the unprecipitated vanadium. The precipitate is extremely hard to handle through a filter press and the lack of a market for any considerable amount of uranium salts makes it nearly always advisable to run the filtrate after precipitation of the vanadium to the sewer without attempting to recover the uranium. Such will be the case, at least, until there is a definite market for the impure sodium uranate.

Recovery of Radium From the Gelatious Silica Press Cakes

The press cakes are dried and ground in a ball mill with one-half their weight of a mixture containing two-thirds lampblack and one-third barium chloride. The mixture is transferred to a graphite crucible and roasted at a temperature of about 1,050 deg. C. The result is the dehydration of the silica and conversion of any sulphates to sulphides. The mixture is permitted to cool and is then transferred to an acid-proof tank, where it is extracted with dilute, sulphate-free hydrochloric acid. When the reaction is complete, the chloride liquor is separated from the residue by filtering through a wooden frame filter press. The press cakes are discarded. The filtrate is run to a tank together with all the sulphate-free water used in washing the press cakes. Washing is continued until the filtrate is free from barium as determined by testing with dilute sulphuric acid. The chloride liquor is then treated with sulphuric acid to precipitate the radium-barium chlorides present as sulphates. The sulphates are separated from the acid solution by filtering through a wooden frame filter press and washing with water until the filtrate is free from acid. These sulphates are treated exactly as were the sulphates from the dissolving tanks. They will be of a higher purity than the sulphates from the dissolving tanks and unless they are combined, after weighing and analysis, with a lot of sulphates obtained by direct extraction, the first carbonates from them can, as a rule, be delivered to the crystallization laboratory.

Part II will be published in a subsequent issue.

German Potash Industry

From statistics published by the Statistische Reichsamt (Federal Bureau of Statistics) it will be noted that the production of potash salts fell greatly during the war, but rose very rapidly from less than 8,000,000 tons in 1919 to over 11,000,000 tons in 1920. The latter figures approximate those for 1912 and 1913, as will be seen from the following, which gives statistics for gross production of potash salts from 1911 to 1920:

	Tons		Tons
1911	9,706,507	1916	8,642,887
1912	11,070,014	1917	8,938,738
1913	11,607,511	1918	*9,438,251
1914	8,171,512	1919	7,772,036
1915	6,879,476	1920	11,386,439

* Alsace production is included in first half of 1918, but not for the later periods.

The refining process through which potash salts are passed before they are sold reduces the weight considerably. The following table contains figures for sales of potash salts for the years 1911-1920, inclusive:

	Metric Tons		Metric Tons
1911	4,541,653	1916	3,775,961
1912	4,736,103	1917	4,598,857
1913	5,187,298	1918	4,834,327
1914	3,998,756	1919	4,155,104
1915	2,991,071	1920	4,313,325

It will be noted in the table following that in 1913 over 500,000 tons of potash was exported, whereas in 1919 there was exported less than 200,000 tons and in 1920 less than 250,000 tons. According to the explanation furnished by the Statistische Reichsamt, one of the principal reasons for this great decrease in the export of potash is the fact that during the war great efforts were made to produce potash in North America so as to become independent of Germany. According to the figures furnished, nearly 250,000 tons was exported to North America in 1913 and only 70,000 tons in 1919.

FOREIGN AND DOMESTIC SALES OF POTASH, 1911-1920

	Sales				
	Domestic				
Year	For Industrial Purposes Metric Tons	For Agricultural Purposes Metric Tons	Total Metric Tons	Foreign Metric Tons	Total Metric Tons
1911	57,498	422,341	479,839	460,088	939,927
1911	65,181	463,384	528,565	480,654	1,009,219
1913	68,180	536,103	604,283	506,086	1,110,369
1914	54,182	483,627	537,809	366,179	903,988
1915	46,887	520,211	567,097	112,679	679,776
1916	44,483	680,561	725,044	158,932	883,976
1917	37,096	834,382	871,478	132,803	1,004,281
1918	38,032	821,684	859,716	141,948	1,001,664
1919	28,266	608,767	637,033	174,969	812,002
1920	.....	.....	690,000	233,644	923,644

Taxation of American Enterprises in Germany

The taxes payable by American enterprises in Germany and the conditions under which the taxation is imposed are enumerated in an article entitled "Taxation of American Corporations in Germany," prepared for the Bureau of Foreign and Domestic Commerce. Multigraph copies have been made and will be supplied by the bureau and its district and co-operative offices to interested inquirers who refer to file No. CL-C2.

Unusual Grain Growth Due to Critical Strain

By A. P. Knight

THE fact that unusually large grains may develop during annealing metals which have undergone a certain amount of cold work is not new. Many investigators have caused the formation of very large grains in critically strained metal by annealing for long periods at temperatures very close to the melting point of the metal in question. It is perhaps not so common for great grain growth to occur due to a critical strain previous to annealing where the cold-working of metal is rather severe and the annealing is done at as low a temperature as is practicable.

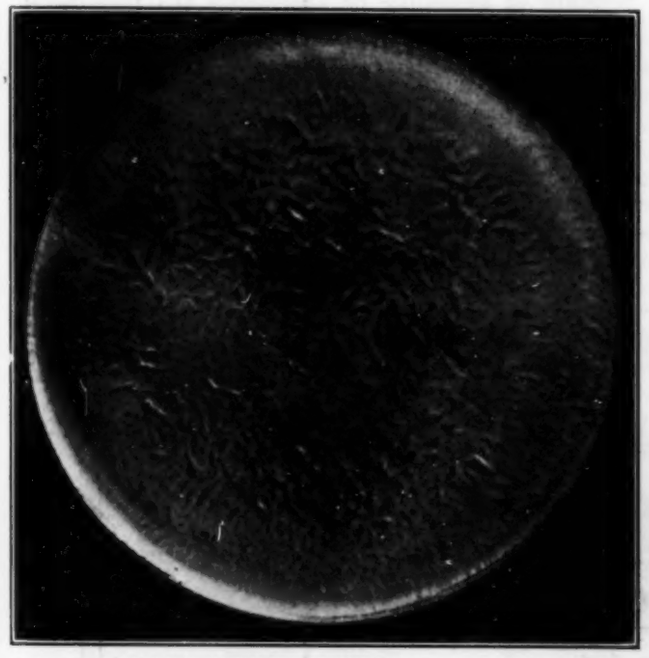


FIG. 1. ROUGH SURFACE OF SHELL AFTER TAPERING.

One of these problems recently taken up for investigation in this laboratory was an aluminum coffee pot, manufactured in this plant, the bottom of which had a very rough appearance, while the sides were smooth. These coffee pots are made by cold-drawing aluminum circles through dies into the form of shells. The shells are then annealed for forty-five minutes in a muffle maintained at 800 deg. F. This method of annealing, which has been used for some time on similar aluminum coffee pots of a smaller size, caused complete softening of the cold-worked metal and produced a fine-grain structure. The shells are then put through a tapering operation which enlarges the diameter of the bottom and forms a tapered shell. Fig. 1, a photograph of the bottom of one of these larger coffee pots, shows this rough appearance. This rough surface did not appear until after the tapering operation, which caused more or less of a stretch in the metal forming the bottom. Fig. 2 shows the shell cut in half just before the tapering operation, placed inside a shell split after tapering. It will be noticed that the second operation reconverts the lower portions of the side walls into part of the bottom, thus shortening the length of the shell.

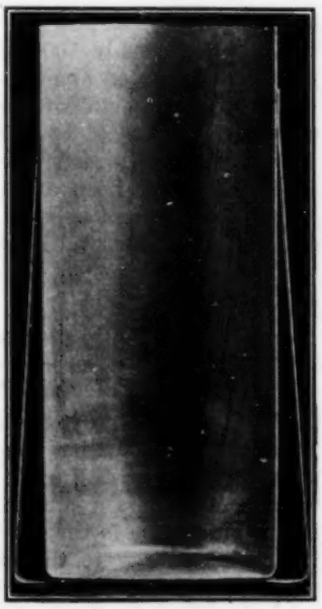


FIG. 2. VERTICAL SECTION OF SHELLS AFTER DRAWING AND AFTER TAPERING. ½ ACTUAL SIZE

The bottom of the pot shown in Fig. 1 was etched with hydrofluoric acid in order to develop the grain structure, as it was suspected that the rough surface was due to deformation of very large grains previously caused by "overannealing." Fig. 3 is a photograph of this bottom after etching. As can be seen, the metal in the bottom of this aluminum coffee pot is composed of crystals which are unusually large. It will also be noted that the shape and size of the overgrown crystals in Fig. 3 correspond to the rough spots in Fig. 1, and the bottom of the shell after the first forming operation (Fig. 2). It is evident that the rough spots in Fig. 1 are individual grains of great size which are more clearly shown on etching. Some of these grains measured as much as ½ in. in length.

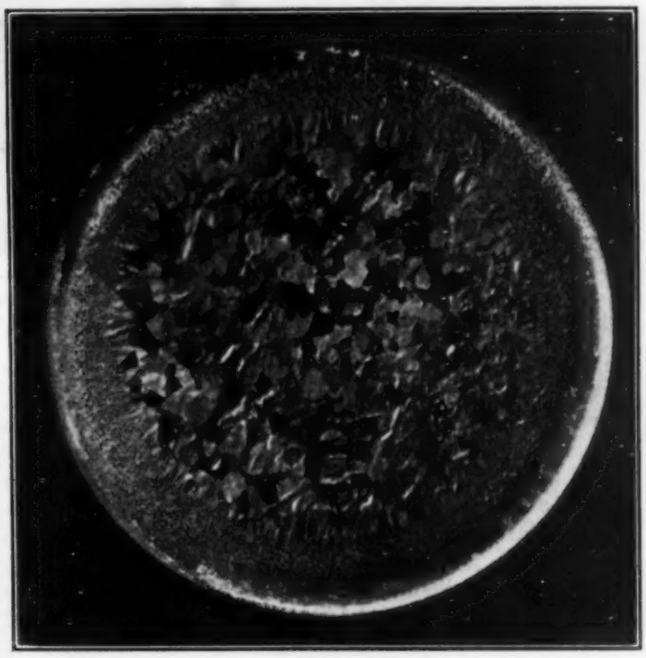


FIG. 3. ETCHED SURFACE SHOWN IN FIG. 1. ½ ACTUAL SIZE

Such observations led to the belief that the outer edge (about ¾ in. in width), composed of small grains, represented metal drawn down from the side and much more strongly worked than the original bottom, both before and after the anneal. It appeared also that the inner portion was metal which must have undergone a very moderate amount of work.

It was at first thought that these coffee pots had been annealed at too high a temperature. If this had been the case, the whole shell would have shown large grains, but it was found upon examination that the large grains were confined to the bottom of the tapered

shell. The walls or sides of the shell were found to be composed of uniformly small grains characteristic of properly annealed aluminum.

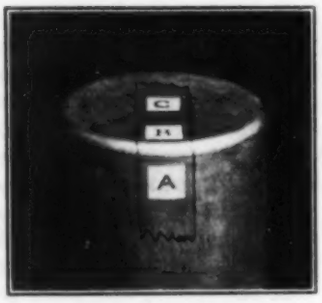


FIG. 4. STRIP CUT FROM SHELL BEFORE ANNEALING OR TAPERING

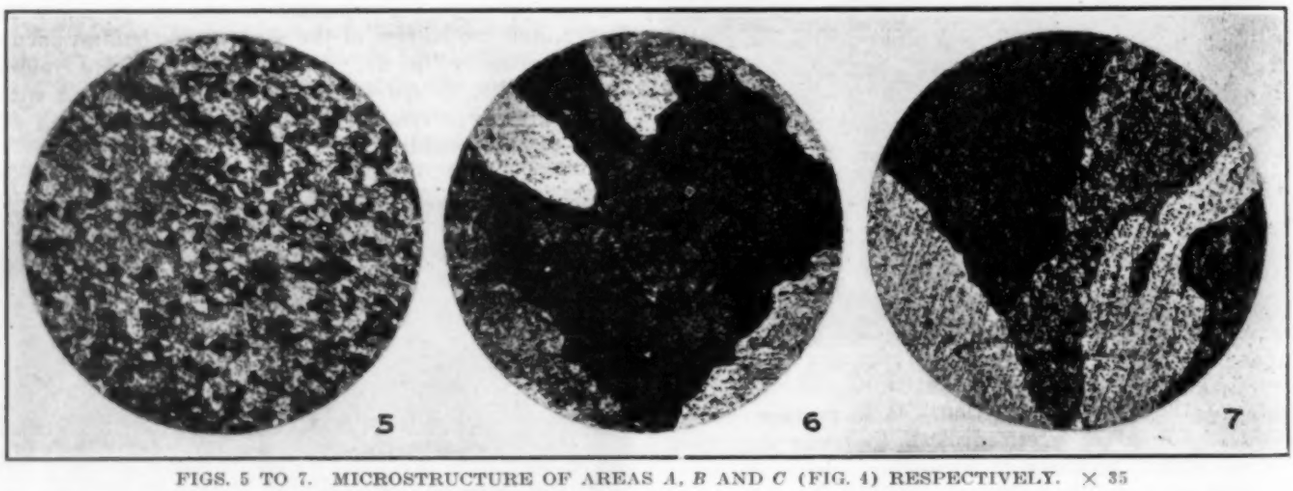
In order to settle the question as to whether the cause of the unusually large grains in this article was local overheating, one of the cylindrical shells before it had been annealed was taken and a strip ½ in. wide extending across the bottom and part way up the side was cut out with a hacksaw. This strip was then annealed in a small laboratory electric muffle at a uniform temperature of 900 deg. F., for one hour. Under these conditions cold-worked aluminum should show a uniformly small grain structure.

Microphotographs were made from the annealed strip of metal at the Points *A*, *B* and *C*, the locations of which are shown in Fig. 4. Fig. 5, taken from the side of the shell quite near to the bottom (Position *A*), shows a fairly fine grain for aluminum. *B* and *C* are represented in Figs. 6 and 7, and show such great grain size that only part of any one crystal can be shown at the magnification used—in fact, these are the smallest crystals that could be found in the section.

The only conclusion that can be arrived at from the above microphotos taken from a small strip of metal which has had a uniform laboratory anneal is that part of this metal was in a "critically strained" condition before annealing. As is well known, metal which has been worked or strained a certain definite amount (usually within fairly narrow limits) will produce very large grains on proper annealing. This is especially true if the metal is annealed for a long time and at a temperature near its melting point. Carpenter and Elam, in a paper entitled "Crystal Growth and Recrystallization in Metals," read before the British Institute of Metals[1] on Sept. 15, 1920, show by a series of elongation tests on aluminum followed by annealing at 1,022 deg. F. for sixty-five hours that this critical point for aluminum corresponds to an elongation of 4 per cent. A test-bar of aluminum elongated 4 per cent and annealed under the above conditions shows grains measuring 1½ in. in length. As the amount of elongation was increased from 4 to 14 per cent in different test-bars, the grain size on annealing decreased to a point where they were barely visible to the unaided eye. In the test-bars which were elongated over 14 per cent, the crystals as shown by the photographs in their paper are too fine to be seen without the aid of a microscope.

With the view of finding out if lowering the temperature of annealing or shortening the time in the muffle would prevent this excessive grain growth, a strip of metal was cut from another aluminum shell and annealed at 700 deg. F. in the laboratory electric muffle for one hour. This strip was polished, etched and examined throughout its length under the microscope. It was found to be composed of uniformly fine grains and to be soft and ductile.

A large number of these cylindrical shells were then annealed in the regular factory muffle at 700 deg. F. and after they had been put through the tapering operation all were examined for rough appearance of the bottom which would denote excessive grain growth. Not one was found that had this rough surface. Apparently a difference of only 100 deg. F. in the annealing temperature prevented abnormal grain growth in the critically strained metal of the bottom of this aluminum coffee pot.



FIGS. 5 TO 7. MICROSTRUCTURE OF AREAS *A*, *B* AND *C* (FIG. 4) RESPECTIVELY. × 35

Since the above tests have been made several lots of these pots have been annealed at the lower temperature and the rough appearance of the bottom has been entirely eliminated, although the metal is formed in the same machines as before and possess the same original deformation.

Research Laboratory,
Rome Manufacturing Co., Rome, N. Y.

[1]CHEM & MET. ENG., vol. 24, p. 224 (Feb. 2, 1921).

Hydro-Electric Projects in Spain

Hydro-electric projects to develop a total of over 750,000 hp. are under consideration in Spain at the present time, according to a recent report of Commercial Attaché Cunningham, Madrid. Of these, the Douro enterprise is the most important and is expected to develop energy to the extent of 450,000 hp. With scarcely 10 per cent of the 6,000,000 hp. of hydro-electric resources in Spain being utilized at this time, further development is essential to the best interests of the country.

The Manufacture of Nitroglycerine

A Concise Account of the Technology Involved in the Commercial Production of Nitroglycerine and a Consideration of the Properties of This Commodity Which Are Responsible for Its Important Industrial Applications

By E. M. SYMMES
Chemical Department, Hercules Powder Co.

WHILE there are many articles in the technical literature bearing on the manufacture of nitroglycerine, most of them refer to small-scale operations or describe processes so old that they cannot be compared with present practice. There have been as many advances in the science of glycerine nitration in the past few years as there have been in similar chemical manufacturing lines, but they have not received the attention here that they deserve and that they have been accorded abroad.

This short article will deal with the manufacture of nitroglycerine as applied to the manufacture of high explosives where large-scale operations are the rule and where chemical purity in the restricted sense is not necessary. This does not mean, however, that purity and stability are neglected, but that only such precautions are taken as to the purity of the product which are important in view of safety and the high quality of the finished material.

From a review of the literature on the subject it might be thought that charges of nitroglycerine of about 100 to 200 lb. each were made, whereas the present practice in modern plants is to nitrate approximately 1,300 lb. of glycerine, producing about 3,000 lb. of nitroglycerine at each operation. About 7,000 lb. of mixed nitric and sulphuric acids is required to accomplish this.

The chemical and physical properties of nitroglycerine have been stated so frequently that reference to them is merely to refresh recollection. Glycerine is a triatomic alcohol, and nitration proceeds according to the equation:

$$C_3H_5(OH)_3 + 3HNO_3 = C_3H_5(NO_3)_3 + 3H_2O$$

Strength and Purity of Materials Used In Making Nitroglycerine

While some small quantity of nitroglycerine would be made by using strong nitric acid according to the equation just stated, the yields would be very low on account of the water which is formed interfering with the course of the reaction. In commercial practice comparatively large quantities of sulphuric acid are added to the nitric acid before use, to combine with the water as fast as it is formed and thus remove this water from the sphere of action. Typical nitrating acids are as follows:

	Per Cent
H_2SO_4	55.00–54.50
HNO_3	42.50–44.25
$HNOSO_4$	0.50– 1.25
H_2O	2.00– 0.00

After nitration, spent acids result. The composition of typical spent acids from the above mixed acids would be:

	Per Cent
H_2SO_4	76.60–75.90
HNO_3	6.40– 6.60
H_2O	17.00–17.30

The nitrosylsulphuric acid should be as low as it is possible to obtain, since it is inert in the nitrating reactions. The sediment, or mud, in the mixed acids should also be as low as possible because sediment contributes to lessened yields of nitroglycerine. Water-white acids are usually used; these are made by permitting the acid to stand in storage tanks until it is in that condition.

In general, the mixed acids should have as little water present as possible, even going so far in this respect as to have a negative quantity. This is accomplished by using only high-strength nitric acid and fuming sulphuric acid, the latter containing 20 to 40 per cent free SO_3. It can be realized that the less water present in mixed acid the less the volume of the spent acid produced, and consequently the less nitroglycerine lost by solution in the spent acid.

The glycerine employed is the so-called dynamite glycerine, an article of commerce which contains about 98.5 per cent glycerine. It has a slight odor, somewhat similar to acrolein, and undoubtedly contains either a slight amount of this body or something similar to it. No effort is made to deodorize it before use in nitroglycerine manufacture. Small quantities of fatty acids are particularly undesirable on account of producing a scum, or slime, later on during the separation of the nitroglycerine from the spent acids, or in washing the nitroglycerine with water to remove the acid it has dissolved. Its specific gravity at 15 deg. C. should be not less than 1.26175. The color of the glycerine is no criterion of its usefulness. A water-white glycerine may sometimes be entirely unsuitable, whereas a dark-colored sample may work perfectly.

Glycerine, when exposed to severe cold, crystallizes into transparent crystals which melt at 17 deg. C. Both crystallization and melting take place slowly.

Use of Glycerine-Sugar Solution and Similar Mixtures

Various patents have been taken out, both in this and in foreign countries, on the use of a glycerine-sugar solution to take the place of glycerine alone. Such a mixture can be nitrated, separated, washed and neutralized in the same way and with the same apparatus as is used with glycerine alone, since the sugar, on nitration, becomes a nitrosaccharose, which is perfectly soluble in the nitroglycerine. On account of the cheaper price of the sugar, an appreciable saving is introduced. A great many tons of cane sugar are consumed in the United States every year in this way by the explosives industry.

Many patents have also been taken out on the production of explosives containing nitroglycerine and other bodies which will lower the freezing point of the mixture to a considerable degree. Most of these are mixtures of nitroglycerine with a nitro-aromatic compound such as nitronaphthalene, nitrotoluene, nitroxylene, and the like, but some depend upon the nitration of a mixture of glycerine and diglycerine. This mixture can be prepared by heating glycerine in contact with a condensing agent, such as sodium carbonate or acetate.

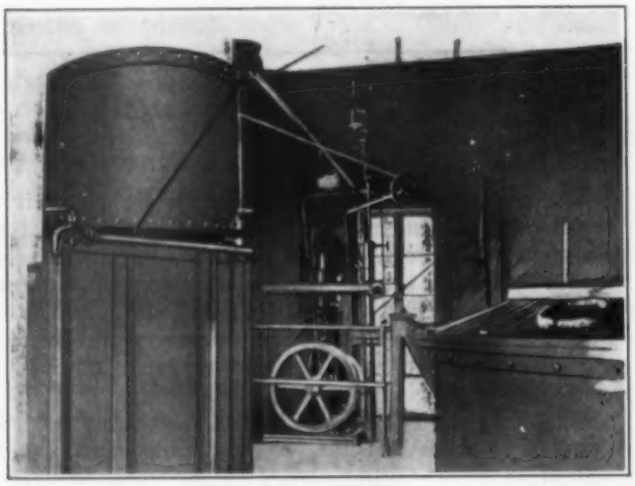


FIG. 1. VIEW OF NITRATOR AND ELEVATED RESERVOIR FOR WEIGHING AND STORING GLYCERINE

Water is split off under such conditions and distilled from the glycerine, leaving a mixture of glycerine and diglycerine, the relative proportions of the two depending upon the time and temperature of heating. Such a mixture can be nitrated, separated, washed and neutralized in the same apparatus used for nitrating glycerine itself.

The appearance of such nitroglycerine substitutes differs little from nitroglycerine itself. The one having a certain substitution of sugar is a little more viscous, and that containing some diglycerine has a slightly darker color.

Description of Nitrator and Its Operation

The type of nitrator in use at the present time is shown in Fig. 1. It will be noted that the reservoir for the glycerine at the left is supported on a frame at such a height that the glycerine will flow by gravity through an iron pipe and spigot to the nitrator. The glycerine feed-tank and its support are on platform scales to permit measuring accurately the quantity used, since the proportion of the glycerine to the nitric acid must be carefully controlled. This glycerine has been previously heated to a temperature of about 100 deg. F. to render it more fluid. This heating is done in a separate house, so arranged that the drums in which the glycerine is received may be drained for 24 hours in a heated room, since glycerine clings very tenaciously to the walls of the container. About 1½ lb. of glycerine will remain clinging to the sides of the drum no matter how long this draining may continue. This amount could be recovered only by washing out the drums with water, an operation which would be uneconomical on plants not having a glycerine refinery.

The mixed acid is weighed out in a tank placed on scales outside the nitrating house and transferred to the nitrator by gravity or compressed air, depending upon the topography of the ground. All of the mixed acid, amounting to about 7,000 lb., is put into the nitrator at once.

The nitrator is of steel-plate construction, having three concentric seamless steel coils in it. These coils carry cold calcium chloride brine to remove the heat of the reaction. Agitation is accomplished by two vertical shafts having paddles at their lower ends. The shafts are supported by a double bearing in the upper framework so that no step-bearing inside the nitrator is necessary. Naturally, such a step-bearing could not be lubricated and would be a source of great danger. The agitator is driven by a steam engine, which can be seen in Fig. 1. A steam-engine drive is subject to fewer interruptions than any other type and its speed can be closely regulated merely by a throttle and governor. Reliability of agitation is important, since, if agitation stops, the incoming glycerine will not be driven under the surface of the cold acid, but will tend to remain on or near the surface of the acid and will cause local heating which will soon lead to decomposition and finally ignition. To avoid the possibility of accident in case the motive power for agitation fails suddenly, a perforated air coil is placed in the bottom of the nitrator, so that the charge can be agitated temporarily in such case.

Temperatures of Nitration

With refrigerating effects commonly employed, a charge of about 1,300 lb. of glycerine will be nitrated in from 50 to 60 minutes. The refrigerating machines in use at the present time are of the 40-ton compression type. To permit sufficient capacity of the brine coolers, about 20,000 gal. of calcium chloride brine is circulated

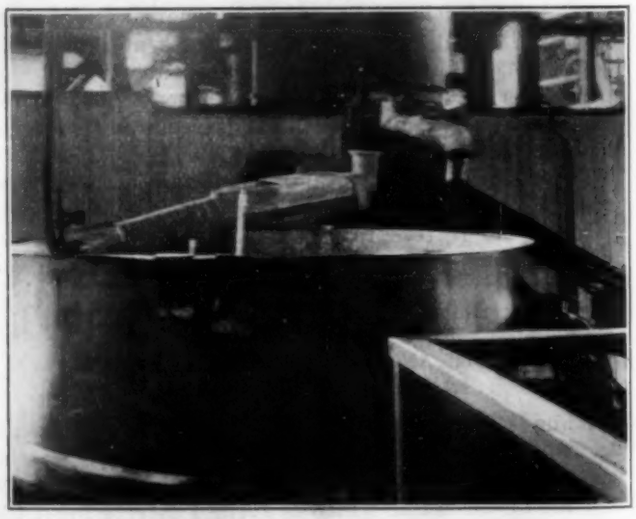


FIG. 2. LEAD TANK IN WHICH NITROGLYCERINE IS SEPARATED FROM THE SPENT ACIDS

from a storage tank through the refrigerating machine and through the coils of the nitrator. This whole amount of brine is brought to a temperature of a few degrees below 0 F. before starting operations in the morning, and will rise only a few degrees as each charge is run through the nitrator.

Temperatures of nitration range from 45 to 34 deg. F., the lower temperatures being used whenever possible. It is well known that the lower the temperature of nitration the higher the yield of nitroglycerine. The temperatures commonly employed are lower than the freezing point of nitroglycerine, yet no freezing takes

place either during nitration or during the subsequent separation, probably because of the influence of the relatively large amount of acid present. That the nitroglycerine does not freeze at these temperatures when undergoing separation and when it contains only a very small amount of acid is probably due to the supercooling phenomenon to which nitroglycerine is subject.

At the end of the nitration a large stop-cock at the base of the nitrator is opened and the emulsion of nitro-

FIG. 3. RUBBER-LINED GUTTERS IN WHICH NITROGLYCERINE FLOWS TO STOREHOUSE

glycerine and spent acid flows down into an open, shallow, lead tank, known as the separator. (See Fig. 2.) Here it is allowed to stand until the nitroglycerine comes to the surface as a clear, pale yellow oil, very similar in appearance to a light lubricating oil, and the milky spent acid has settled to the bottom. The sides of the lead separator have thick plate-glass windows set in by glycerine litharge cement, so that the course of the operation can be watched. On looking through these windows the contents of the separator will first be seen as a homogeneous emulsion. In a few minutes small globules of nitroglycerine can be seen to move slowly upward and on reaching the top merge into a layer of nitroglycerine which spreads over the entire surface of the tank. This action continues until, on looking through the windows, a sharp line is seen between the two layers, when separation is considered complete.

Purification of the Nitroglycerine

The spent acid is then drawn off through a bottom stop-cock and sent to the acid recoveries for working up into nitric and sulphuric acids of usual strengths, to be used over again in the process. The nitroglycerine, still containing a small quantity of dissolved acids, is dropped slowly into a tank of warm water at about 90 to 100 deg. F., agitated with air, and, after settling for a few minutes, is sent to the next house by gravity flow through a V-shaped wooden gutter lined with sheet rubber. (See Fig. 3.) In this house, the so-called neutralizer, it is received in lead tanks holding a solution of sodium carbonate. These are shown in Fig. 4. Such a quantity of sodium carbonate is present as will be certain to show a small excess after all the acid has been neutralized. Agitation is here also accomplished with air. This washing with alkaline solution is continued until the nitroglycerine gives a neutral test to litmus paper. A few hours' settling after this process reduces the moisture which the nitroglycerine contains to 0.30 to 1.50 per cent. The nitroglycerine is stored under a small quantity of the sodium carbonate solution, and drawn out through rubber hose as required for use.

Methods of Handling Nitroglycerine, and Its Important Uses

For transportation to the point of consumption, the dynamite or gelatine mixing houses, or the smokeless powder mixers, the nitroglycerine prepared as above is drawn out of the neutralizing tanks by a rubber hose into small buggies having copper-lined tanks and rubber-tired wheels. The valve controlling the flow of nitroglycerine to these buggies is nothing more than a gigantic laboratory pinch-cock, operating by mere compression of the rubber hose.

The platform scale used to weigh out the nitroglycerine required is covered with sheet rubber, as are also the weights, so that no shock would be possible even if the weights were accidentally dropped. Scrupulous cleanliness is enforced throughout these operations. Workmen are required to wear standard uniforms and nail-less shoes, so that there will be no possibility of shock or friction against metallic objects on the floor.

Important uses for nitroglycerine other than for dynamite are for oil-well torpedoes and double-base smokeless powder. For shooting oil wells a can containing nitroglycerine and provided with a detonating cap is dropped down the well, exploding when it reaches the bottom. Double-base smokeless powder consists of nitrocotton and nitroglycerine, the amounts of the latter sometimes reaching as high as 40 per cent. Such a smokeless powder has many advantages over one made of nitrocotton only, and is the standard military powder for Great Britain.

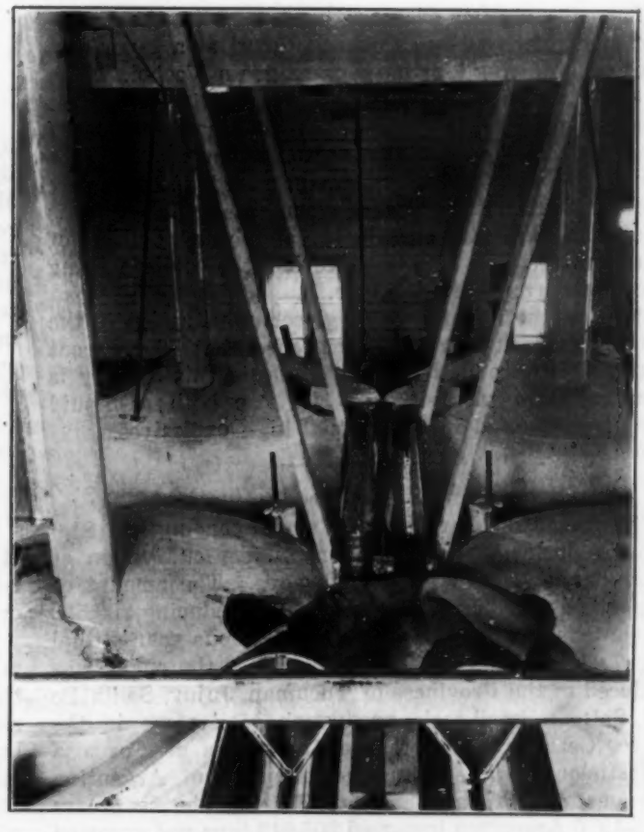


FIG. 4. NEUTRALIZERS IN WHICH FINAL PURIFICATION IS EFFECTED

Physiological Properties of Nitroglycerine

Nitroglycerine exerts a temporary poisonous effect on human beings. The small quantities of it volatilized in the air of the working buildings will give a person unaccustomed to it a severe headache in the course of a few minutes. Mere contact with the skin also results promptly in headaches, on account of the rapid absorption into the system. Such headaches last for about 12 hours, and after this time no permanent ill effects are ever observed. Contact with nitroglycerine for two or three days causes the system to build up an immunity to its effects, and after this period none of the poisoning effects is noticed. Such immunity is very quickly lost, however. Absence from work for two days or more will destroy it, and the painful process of again acquiring it will have to be repeated.

Extensive medical investigations have shown that no permanent ill effects are suffered by workmen in a nitroglycerine plant. Every large explosives company has in its employ many old and experienced workmen who have been in contact with nitroglycerine every working day for many years. No ill effects which could in any way be attributed to nitroglycerine have ever been proved, in spite of thorough medical investigations undertaken with the idea in mind that such ill effects were present. This differs markedly from experience in the manufacture of many or all of the nitro-aromatic explosives, where severe, definite and permanent poisonous effects are experienced unless great precautions are taken to prevent entry of such compounds into the human system.

This article is intended to cover only a few points in connection with manufacture of nitroglycerine for ultimate use as dynamite or gelatine dynamite, blasting gelatine, smokeless powder or as a liquid for shooting oil and gas wells. These uses comprise practically the entire consumption of nitroglycerine with the exception of a relatively small quantity used as a 1 per cent solution of nitroglycerine in pure grain alcohol, which is employed in medicine as a heart stimulant. No chemical process is involved in the manufacture of dynamite and gelatine dynamite, assuming that the nitroglycerine has already been prepared, since a mere incorporation with suitable absorbents is all that is required. Blasting gelatine is simply a solution of soluble nitrocotton in nitroglycerine, the solution being aided by warming the mixture.

To show the importance of glycerine nitration in the United States it might be mentioned that 50 per cent of the entire production of glycerine in this country is converted into nitroglycerine for use both as liquid nitroglycerine and in commercial high explosives.

Wilmington, Del.

Argentine Cane-Sugar Production in 1920

The Argentine Director of Rural Economy and Statistics reports that the total area under cultivation of sugar during 1920 was 233,700 acres. The amount of cane milled was 3,099,722 metric tons, producing 209,553 metric tons of sugar. During the previous year a total of 297,640 tons was produced. Most of the sugar was produced in the Provinces of Tucuman, Jujuy, Santa Fe and Salta. Small-scale production took place in the Chaco, Corrientes and in the Territories of Formosa and Misiones. The annual consumption of Argentina averages 220,000 metric tons. During the six years 1915-1920 Argentina imported 305,913 tons and exported 137,534 metric tons of sugar.

A New Salt Cake and Hydrochloric Acid Furnace

By N. A. Laury

IN THIS journal in May, 1913, there appeared an article from *Zeitschrift für Angewandte Chemie* by Dr. Theodor Meyer in which he said: "The great problem of the muriatic acid industry—the mechanical furnace—is still a problem of the future, and for the present there is little hope that it will soon be solved." Two types of furnaces, both survivals of early days, are still the only ones in common use. Against the pot and muffle furnace there stands the objection of heavy and disagreeable hand labor, and against the mechanically agitated muffle, commonly represented by the Mannheim furnace, there are the poor quality of the salt cake, small capacity and rapid wear of moving parts.

The plant described herein, on which the writer has filed patent papers, was built last year by the Aetna Explosives Co. at Emporium, Pa., and is being successfully operated. It is an internally oil-fired rotary, requiring no hand labor except charging, and it produces 20 tons of good salt cake a day with a minimum of wear.

The most obvious difficulties expected either did not appear at all or were at length overcome. The absorption of the hydrochloric acid from the very dilute gas

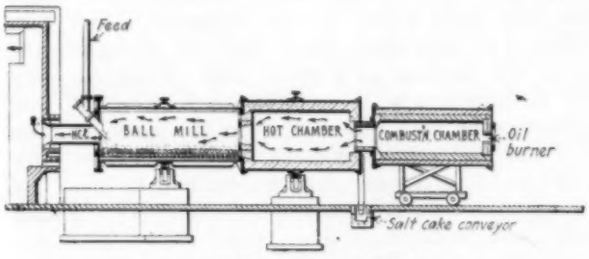


FIG. 1. BALL MILL FURNACE

to form acid of commercial strengths was accomplished by ample cooling of the gas and recirculation of the absorbing acid. The design and specific proportions required for the provision of sufficient heat at one end to produce high-grade salt cake, without causing fusion of the charge in any part of the furnace or wasting too much heat at the outlet, were based on data obtained in small-scale experiments. Owing to the internal application of the heat, the charge does not cake on the walls objectionably. A protective crust 2 in. thick forms over the brick lining, so the bricks are never exposed and thus last indefinitely.

The Furnace

Fig. 1 shows a longitudinal elevation of the furnace. It consists of a combustion chamber with oil-burning equipment and a horizontal two-chambered revolving cylinder.

The combustion chamber is lined with firebrick and mounted on a truck for convenience in moving to reach the interior of the furnace. It is made of ½-in. steel shell 10 ft. long and 4 ft. 8 in. in diameter. The combustion chamber nozzle, which projects slightly into the furnace, is a plain iron casting lined with firebrick. The oil burner is the low-pressure type. It is supplied with air by a Sturtevant blower and with oil by Goulds pumps. The air and oil connections are flexible to

permit the fore and aft movement of the combustion chamber. There is a course of SiloCel brick between the shell and the firebrick lining. This fully protects the shell and saves heat, as at full operation the hand can be borne on the shell.

The furnace is a steel shell in two sections of different diameters, united in the middle by cast-steel flanges. The front or hot section has a 9-in. firebrick lining. Its diameter inside this lining is 4½ ft. and its length 10 ft. It has a plain unlined cast-iron head with a central port 2 in. greater in diameter than the combustion chamber nozzle, to permit discharge of the salt cake. The latter is also beveled toward the bottom to give more room for the discharge. A casing is loosely fitted around this end of the furnace through which the salt cake drops to a worm conveyor. A fan is connected to the top of this casing to conduct the smoke from the hot salt cake to the stack. At the junction of the two sections of the furnace and dividing them into separate chambers there is a cast-iron plate which is bolted to the cast-steel flanges. This plate has a 2-ft. hole in the center for the gas and radial slots near the periphery through which the salt cake passes from the grinding chamber to the hot chamber.

The grinding chamber is lined with chilled iron plates. It is 12 ft. long and 4½ ft. in diameter. It has a cast-iron head which also has a chilled iron lining. It is insulated with asbestos covering. The grinding is done by 3-in. diameter cast-iron balls. An 18-in. cast-iron flue conducts the gas from the grinding chamber to the dust chamber. The charging of the salt and niter cake is also done through this flue.

The large gear on the furnace is driven by a pinion and chain and a 50-hp. motor. After the first few revolutions at starting a little less than 25 hp. is all that is required. The furnace rotates at 20 r.p.m.

The Absorbing System

The gas is freed from dust, filtered free of sulphuric mist, cooled and absorbed in water.

The dust chamber is made of red brick with an inner

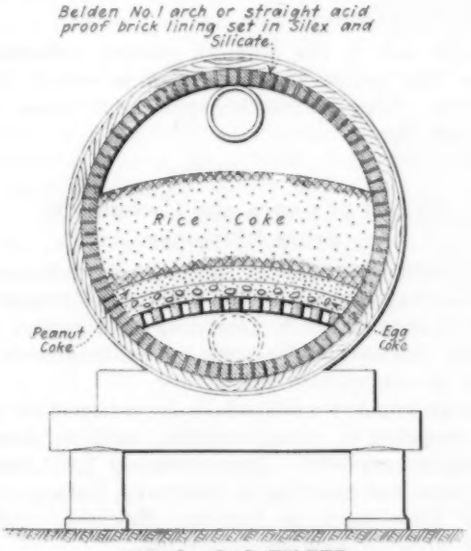


FIG. 2. GAS FILTER

course of acid brick. It is 10 ft. square, 15 ft. high and the walls are 16 in. thick. There are clean-out doors at the bottom.

A 12-in. chemical stoneware line about 50 ft. long conducts the gas to the filter. This is a wooden tank with tarred staves and acid-brick lining. (See Fig. 2.) It is 6 ft. in diameter and 20 ft. long. The filtering medium is a bed of rice-sized coke 24 in. deep.

The coolers consist of four rows of 6-in. silica ware S pipe over which water is run.

The gas goes to the towers (Fig. 3) through two 8-in. lines; one to each row of six towers run in parallel. From the tower outlets 8-in. connections join at the Duriron fan inlet. The towers are 2½ ft. in diameter and 15 ft. high and are made of chemical stoneware and packed with ordinary ring packing resting on brick grills. In each row of six the gas travels up the first three through a common header, down the next two and up the last. The water is run into the last tower of each row and the HCl solution is circulated at the rate of about 30 lb. a minute on each tower by a pulsometer.

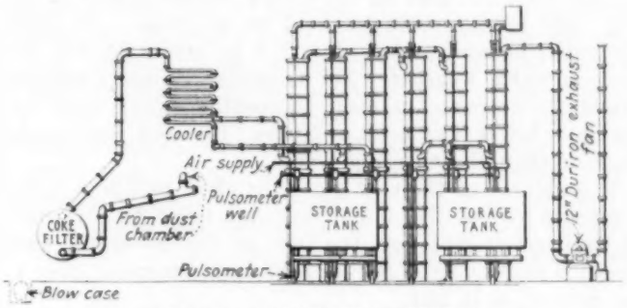


FIG. 3. ABSORBING SYSTEM

The air, separated in the pulsometer splash boxes on the tops of the towers, goes through a 3-in. chemical stoneware line to a coke-packed vessel over the last towers, where it is scrubbed free of HCl by the incoming fresh water for the towers.

The acid is stored in two rubber-lined wooden tanks 12 ft. diameter and 8 ft. deep.

A cheap and very good cement for the stoneware joints is made by stirring into melted coal-tar pitch a small amount of ground barytes, silica or china clay and some short-fibered asbestos. The proportions are chosen for the different joints so that the cement does not get too hard on the cold ones or too soft on the hot ones. A ring of asbestos rope is first placed in the joint and the cement then worked in like putty before it cools.

Operation

The normal rate of running is 1 ton of salt cake an hour. This requires 9 to 10 gal. of fuel oil. The burner is easily regulated so that a sootless gas enters the furnace. The heat is regulated according to the quality of the cake. Prime cake has to come out of the furnace at somewhat above 1,000 deg. F. The niter cake is coarsely ground in a single roll coal crusher weighed in a buggy, the required weight of salt shoveled on top of it and the charge slowly dumped into the elevator. This is done every 4 or 5 minutes according to the size of charge handled. It is thoroughly ground in the grinding chamber of the furnace and also has given off 25 per cent of its HCl when it reaches the hot chamber. The balls are always free and clean and the walls of the grinding chamber never get coated.

To keep the crust of cake on the brick lining of the hot chamber at the right thickness a loose rail 9 ft. long is kept in it. If two or three heavy rails are used, the crust is all cut away, but if only a light one or none at all is used the crust gets too thick. The

outside of the furnace is always cool enough to bear the hand.

If there is any interruption of the feed, the fire must be shut off or the charge will fuse on the middle plate and close up the ports. The combustion chamber then must be pushed back and the ports opened with long bars. The operators soon learn to avoid this troublesome job.

The gas leaves the furnace at 300 deg. F., which is close to the minimum that prevents condensation in the grinding chamber, iron flue and dust chamber and represents the best fuel economy possible in the apparatus. Condensation starts in the flue to the filter. The temperature at the filter inlet is 160 deg. F. and at its outlet 125 deg. F. and the coolers bring it down to 80-90 deg. F.

The acid circulated on the strong towers is kept at 20 deg. Bé. unless stronger acid is required. At this strength its temperature does not go above 85 deg. F. even in warm weather. The temperature and strength gradually decrease in each succeeding tower until in the last tower the acid is 3 deg. Bé. and not much warmer than the entering water.

The volume of the cool gas runs close to 2,000 cu.ft. a minute and at the fan it contains 0.006 g. per liter of unabsorbed HCl. At the inlet to the tower the gas contains about 0.05 g. per liter, so that somewhat over 1 per cent of it is lost.

The constant volume and composition of the gas greatly simplifies the filtering, cooling, absorption and the control of the strength of the product. Unlike the intermittent processes, the latter takes care of itself if the water is admitted uniformly.

Points to Be Considered in Operation of Absorption System

Acid of 20 deg. Bé. has been made with gas containing even less than 3 per cent HCl by volume. This is explained by the cooling effect of the pulsometers, the circulation of 350 to 400 lb. of acid a minute and particularly by the distribution of the absorption over a number of towers in which each step in the process is carried on separately.

Guide posts in rational absorption are indicated by the partial pressures of aqueous hydrochloric acid of different strengths:

Deg. Bé.	Mm. Hg.	Deg. F.
22	174	86
20	33.3	86
19.95	31.5	86
19.2	15.5	86
13.36	0.57	86
3	0.00117	77

At 3 deg. Bé., the strength of the acid in the final tower, the partial pressure is so low and the solubility of HCl is so great that even a very dilute gas is absorbed. This is illustrated by the fact that the small amount of 3 deg. Bé. acid drawn into the fan is rapidly concentrated to 13.36 deg. Bé. by the exit gas containing only 0.0006 g. per liter, unless it is continuously drained out. Below 13.36 deg. Bé. the conditions for absorptions are most favorable. The specific heat of the solution drops but little relatively, while the heat of solution of the HCl has not yet reached its maximum. Furthermore, 13.36 deg. Bé. is the most stable concentration, as it can be distilled without change of strength at 227.37 deg. F.

From 13.36 deg. Bé. to the standard strength of 20 deg. Bé. the process should be regarded as one of concentration. The stronger and cooler the gas the better, and the solution should be circulated in large volume. At 19 to 20 deg. Bé. there is a sharp rise in the partial pressure. This is the standard strength and seems to be the maximum for stability. At 22 deg. Bé. the partial pressure is so high that there is considerable loss of HCl on exposure and it should not be used except where this loss is overbalanced by a special demand.

There should be a good in-pull at the joint between the furnace and the flue to the dust chamber. At the top of the dust chamber the draught is normally minus $\frac{1}{8}$ in. of water, at the filter inlet minus $\frac{3}{4}$ in., at the cooler inlet $1\frac{7}{8}$ in., at the inlet to the towers minus $2\frac{3}{8}$ in. and at the fan inlet minus 5 in. The fan is driven at a speed of 1,500 r.p.m. by a 5-hp. motor.

The plant requires a charge man, a tower man and a furnace operator for 24 hours. A repair man and helper are usually kept busy in the daytime.

Quality of Products

All commercial strengths of acid can be made. It is clear and has the usual light yellow color. It compares in analysis with pot and muffle acid as follows:

	Deg. Bé.	H_2SO_4 Per Cent	Fe Per Cent	As_2O_3 Per Cent	Free Cl
Rotary	20	0.07	0.02	0.00013	Trace
Pot and muffle	20	0.09	0.02	0.00003	Trace

It was proved by absorbing gas from the furnace through distilled water in glass apparatus that the iron in the product comes from the action of the acid on the material of the towers and packing.

The salt cake is of good color and compares in analysis with pot and muffle cake as follows:

	H_2SO_4	NaCl	Fe_2O_3	Al_2O_3	Insol.	$CaSO_4$
Rotary	1.21	1.68	0.31	0.21	0.32	0.54
Pot and muffle	1.40	0.90	0.20	0.10	0.33	1.32

The size of the cake particles in the cold stockpile is shown by the screen test:

	NaCl, Per Cent	H_2SO_4, Per Cent
Whole sample	1.33	1.04
On 10 mesh, 10.6 per cent	1.65	1.10
On 30 mesh, 30.9 per cent	1.38	2.78
On 40 mesh, 6.2 per cent	1.47	0.63
On 50 mesh, 5.4 per cent	1.42	0.29
On 60 mesh, 2.9 per cent	1.42	0.29
Through 60 mesh, 42.8 per cent	1.24	0.28

The high salt in the 30-mesh portion indicates that these are the largest lumps that come out of the furnace. The 10-mesh fraction probably lumps up on cooling outside.

Rockville Center, L. I.

Export of Copra and Coconut Oil From Pilippines

Nearly 10,000,000 kilos of copra cake, copra and coconut oil was exported from the Philippine Islands from Aug. 13 to Aug. 25 last, according to a report of the Philippine Bureau of Customs. The shipments were valued at several million pesos.

The huge consignment, which is believed to be the biggest exported in many months, went to American and European markets. Approximately 1,811,000 kilos of copra cake was exported to Hamburg, Germany, while 1,222,000 kilos went to London, England, and over 1,100,000 kilos to American markets.

The copra shipments were distributed as follows: 1,060,000 kilos went to Germany, 318,000 kilos to Holland and 304,000 kilos to America.

Coconut oil went mostly to the United States, to the amount of 1,222,000 kilos. Holland received 670,000 kilos and London 670,000 kilos.

A Bibliography and Abstracts of Chromium Steels

Chronological Arrangement of Some of the Principal Papers on Chromium and Chromium Alloy Steels Published During the Period 1798 to 1919, With Brief Summary of Their Scope

By F. P. ZIMMERLI

THIS bibliography on chromium, or chromium alloy steels, is arranged in chronological order. An effort has been made to abstract papers dealing directly with chromium steels and such parts of other papers found to deal with chromium steels. In case the original article was not read it is so stated and both the abstract read and the original journal are listed. In no case, however, are abstracted articles used if the original could be obtained.

From 1798 to 1877

(1) Memoirs on a new metallic substance contained in red lead of Siberia and which one proposes to call "chrome" on account of the property it possesses of coloring the combinations which it enters. L. N. Vauquelin. *Ann. Chim.*, 1798, vol. 25, pp. 21-31 and 194-204.

(2) Concerning the alloys of chromium with iron and with steel. M. P. Berthier. *Ann. Chim. Phys.*, 1821, vol. 17 (second series), pp. 55-64. By fusion in a crucible using forced draft coke fire steel containing 1 to 1.5 per cent chromium was obtained. A knife and a razor made from them had a beautiful damascened finish.

(3) On the alloys of steel. J. Stodart and M. Faraday. *Phil. Trans.*, Roy. Soc. of London, part 1, 1822, pp. 253-270. The authors prepared two alloys of steel and chromium on a laboratory scale. The chromium added should have resulted in approximately 1 and 3 per cent. They were malleable and gave a fine damask.

(4) Note on the crystallization and alloys of chromium. M. E. Fremy. *Compt. rend.*, 1857, vol. 44, pp. 632-634. He reduced chromate and oxide of iron by charcoal, into an alloy with a needle-like structure, very hard, scratching quartz and hardened steel.

(5) Alloys of iron and chromium. M. Sergius Kern. *J. Iron and Steel Inst.*, 1875, vol. 2, pp. 654. A note to the effect that a 74Cr:25Fe alloy was glass hard and that 97.5Fe:2.5Cr was found malleable.

(6) On chromium pig iron made by the Tasmanian Iron Co. E. Riley. *J. Iron and Steel Inst.*, No. 1, 1877, pp. 104-108. It contains 6 to 7 per cent Cr, has a high melting point and is difficult to puddle. Oxide of chromium makes a thick cinder. Welding experiments showed that Cr has none of the deoxidizing powers of Mn.

From 1878 to 1886

(7) Note on chrome steel. G. Rolland. Abstracted in *Proc.*, Inst. of Civil Engineers, vol. 53, 1878, p. 384, from *Ann. des Mines*, vol. 13, p. 152. Chromium increases the hardness and strength but it cannot replace carbon. Analyses show from 0.08 to 9 per cent Cr. Carbon as high as 1.10 per cent. At this time the steel was made only at Brooklyn (U. S.), Sheffield, (England) and Unieux (France) by crucible or Siemens' furnace.

(8) Magnetization of iron. John Hopkinson. *Phil. Trans.*, Roy. Soc. of London, vol. 176, 1885, part 2, pp. 455-469. Magnetic tests, specific resistance and chemical analysis of 35 chromium steels (forged, annealed and oil-hardened). No marked effect of Cr indicated.

(9) Note on the production, constitution and properties of chrome steel. M. Boussingault. *J. Iron and Steel Inst.*, 1886, vol. 2, pp. 807-830. Shows that Cr does not give iron a tempering power as carbon does, contrary to the assertions of Julius Bauer. Brief description of the difficulties involved in manufacture.

(10) On chrome, pig iron and steel. M. Brustlein. *J. Iron and Steel Inst.*, 1886, vol. 2, p. 770. Describes fracture and a few physical properties of chromium alloys produced at the Unieux works (France).

From 1887 to 1892

(11) The status of chrome steels. H. M. Howe. Abstracted in *J. Iron and Steel Inst.*, 1887, vol. 2, p. 345, from *Eng. and Min. J.*, vol. 14, p. 242. Suggests the following definition: Chromium steel is a variety of steel the physical properties of which are influenced more by chromium than by other non-ferrous elements it contains. This shuts out so-called chromium steels containing but traces of chromium, or none at all.

(12) Note on chrome steel projectiles. *J. Iron and Steel Inst.*, 1887, No. 1, p. 458.

(13) Chrome steel. B. F. Hart and J. Calish. Abstracted in *J. Iron and Steel Inst.*, 1889, No. 1, p. 376, from *Iron*, vol. 33, p. 78. Manufacturing methods at Brooklyn. Tests employed on material used in St. Louis bridge.

(14) On critical points of iron and steel. F. Osmond. *J. Iron and Steel Inst.*, 1890, No. 1, pp. 38-80. Determines that presence of Cr considerably raises Ar_1. Influence of the maximum temperature before cooling on Ar_1 is greater in Cr than in C steels. A brief bibliography is appended.

(15) Alloys of iron and chromium. R. A. Hadfield, including a report by F. Osmond. *J. Iron and Steel Inst.*, 1892, No. 2, pp. 49-175. Early history and a description of the element Cr and methods of preparing it. The physical properties of ferrochromium and of chromium alloys with, and very low in, carbon. Chromium cannot replace carbon as a hardener, merely acting as an intensifier. In an appendix methods of preparing pure chromium are given. F. Osmond concludes that Cr interferes with and impedes the crystallization of iron. Location of critical points and their change with rates of cooling are reported. Chromium exists in elemental solution, in a compound of Cr, Fe and C in isolated particles, and the same compound

in solid solution. The melting points of some ferros are given.

(16) Chrome steel: its manufacture and uses with complete chemical analyses. F. Hart, Jr., and J. Calish. *Stevens Indicator,* vol. 9, 1892, pp. 49-65. A general article in which the authors give a list of the uses of various chromium steels; describe the more important chromium ores, the method of producing the alloys—especially that employed by the Brooklyn (N. Y.) Chrome Steel Works—their properties and methods for their chemical analyses.

FROM 1893 TO 1894

(17) Preparation of chromium and manganese at a high temperature. H. Moissan. *Compt. rend.*, vol. 116, 1893, pp. 349-351. Chromium oxide mixed with carbon is reduced with a current of 50 v. and 350 amp. Carbon analyzes up to 13 per cent, but if it is broken up, placed in a crucible, brasqued and covered with chromic oxide, Cr quite free from carbon results. By using mixed ores perfectly homogeneous Fe:Cr alloys are obtained.

(18) Some alloys of iron with molybdenum, tungsten and chromium as solutions. J. A. De Benneville. *J. Am. Chem. Soc.*, 1894, vol. 16, pp. 735-757. Alloys, with the exception of some amalgams, are solids at ordinary temperatures; as a solution, they exist only at high temperatures where the laws of solutions apply. From studies of acid attack he finds: (1) A chemical union between constituents. (2) These compounds are distributed uniformly through the alloys. (3) The more stable alloys are definite chemical compounds. (4) The less stable may be definite compounds such as cryohydrates.

(19) The physical influence of elements on iron. J. O. Arnold. *J. Iron and Steel Inst.*, 1894, No. 1, pp. 107-155. Carbide formed by high chromium is noted and the location of critical points given.

(20) Cementation steel, ferrochromium, ferrotungsten and chromium steel. H. Behrens and A. R. Van Linge. Abstracted by *J. Am. Chem. Soc.*, vol. 66, part 2, 1894, p. 452, from *Rec. Trav. Chim.*, vol. 13, pp. 155-188. Ferrochromium contained crystals (hardness in a ground mass of hardness 4.2). The latter is a much better heat conductor. Acids leave bayonet-shaped crystals, non-magnetic, hardness 7.5, analysis approaching $Cr_2Fe_7C_2$. Softer portions of the alloy contain considerable Cr and the hardness is closely connected with the quantity of carbon present.

(21) Chromium. H. Moissan. *Compt. rend.*, vol. 119, 1894, pp. 185-191. Heating chromium with large excess of carbon in electric furnace gives Cr_3C_2 in brilliant lamellæ with a greasy luster. Insoluble in concentrated or dilute nitric acid, aqua regia or concentrated HCl. Fused KNO_3 attacks it readily. Sp.gr. 5.62; harder than topaz, softer than carborundum. Another carbide, CCr_4, is obtained in lustrous needles sometimes 20 mm. long; sp.gr. 6.75; harder than glass or quartz.

FROM 1895 TO 1902

(22) Ternary alloys of iron with chromium, molybdenum and tungsten. J. De Benneville. *J. Iron and Steel Inst.*, 1895, vol. 1, pp. 202-253. By use of different solvents the author detects $Fe_7Cr_3C_4$ and $Fe_3(CrMo)_3C_4$ and carbides of iron other than Fe_3C. An excellent physicochemical investigation.

(23) Chromium:iron alloys. L. Schneider. *J. Iron and Steel Inst.*, 1896, vol. 1, p. 398. Abstracted from *Oesterreichische Z. Berg und Hüttenwesen,* vol. 33, p. 297. Rich Fe:Cr alloys which are occasionally used to manufacture exceptionally hard steels exhibit crystals in blow-holes and on the surface, increasing with the chromium.

(24) Welding chrome steel. R. Brown. *J. Iron and Steel Inst.*, 1896, No. 1, p. 472. Successful welding can be done with light blows gradually increasing in strength.

(25) The magnetic properties of iron. Dewar and Fleming. Abstracted by *J. Iron and Steel Inst.*, 1896, No. 2, p. 397, from *Proc.*, Roy. Soc., vol. 60, pp. 57-71. Chromium steels were studied at low temperatures.

(26) A new silicide of chromium. Ch. Zettel. *Compt. rend.*, 1898, vol. 126, pp. 833-834. A compound, $SiCr_2$, is reported to be very stable and insoluble except in HF.

(27) Researches upon the combinations of silicon and chromium in ferrous products. A. Carnot and Guital. *Compt. rend.*, 1898, vol. 126, pp. 1240-1245. $3(Cr_3C_2)(Fe_3C)$ exists in ferrochromium; $(Cr_3C_2)3(Fe_3C)$ in low-chromium steel.

(28) Magnetic properties of hardened steels. Mrs. Sklodowska Curie. Société d'Encouragement pour l'Industrie Nationale, 1898, pp. 37-76. Deals with magnetic properties of forty-eight hardened steel magnets in the form of rings and 20-cm. bars.

(29) Researches on the electrical conductivity and magnetic properties of upward of one hundred different alloys of iron. W. F. Barrett, W. Brown and R. A. Hadfield. *Proc.*, Inst. of Electrical Eng., vol. 31, 1900, pp. 674-729. Gives the list of specimens tested; study of their electric conductivity and magnetic properties.

(30) On the increase of electrical resistivity caused by alloying iron with various elements and the specific heat of those elements. W. F. Barrett. *Proc.*, Roy. Soc. of London, vol. 69, 1902, pp. 480-485. Among others three chromium-bearing irons were examined ranging from 2 to 9.5 per cent Cr plus slight impurities.

(31) Magnetic properties of iron. A. Abt. Abstracted by *J. Iron and Steel Inst.*, 1902, No. 2, p. 537, from *Ann. der Physik.*, vol. 6, pp. 774-783. Abt measured the permanent magnetic moment in a large number of hardened steels in different fields. Ni:Cr steel shows the greatest moment, then follow steels containing Cr, Ni, W, C and Mn.

(32) Concerning the magnetic properties of iron and steel at low temperatures. C. C. Trowbridge. *Electrical World and Eng.*, 1902. Abstracted by *Stahl und Eisen,* 1903, vol. 23, No. 1, pp. 150-151. Influence of low temperature depends on the chemical constitution and temporary physical condition, thermal and mechanical treatment of the sample.

FROM 1903 TO 1904

(33) Determination of the points of allotropic changes of iron and its alloys by the measurements of the variations in the electrical resistance. O. Boudouard. *J. Iron and Steel Inst.*, 1903, No. 1, pp. 299-377. Thermal analysis of chromium steels indicates the existence of an anomaly at the same temperatures on heating and cooling.

(34) Properties and constitution of chrome steels. Leon Guillet. *Compt. rend.*, No. 139, 1904, pp. 426-428. Heat-treatment of nineteen different alloy steels gave results somewhat similar to straight carbon steels except in case of double carbide steels.

(35) The development and use of high-speed steel. J. M. Gledhill. *J. Iron and Steel Inst.*, No. 2, 1904, pp. 127-166. Discusses high-tungsten and low-chromium steels.

(36) Chrome steels, L. Guillet. *Revue de Métallurgie*, 1904, pp. 155-184. Carbons from 0.043 to 0.464 per cent; Cr from 0.703 to 31.74 per cent discussed. Hardened pearlitic chromium steels act like carbon steels during quenching. Martensitic Cr steels soften somewhat on quenching, due to a tendency to form gamma iron, the less the lower the carbon. Annealing also softens. Double carbide Cr steels are softened by a quench from 850 deg. without undergoing any microscopic change. At 1,200 deg. C. the carbides dissolve in part or totally according to speed of cooling and initial content. Annealing destroys the double carbide in part.

(37) Heat-treatment experiments with chrome: vanadium steel. H. R. Sankey and J. R. Smith. *Inst. Mechanical Engineers*, parts 3 and 4, 1904, pp. 1235-1317. Open-hearth furnace steel containing C 0.297, Si 0.059, Mn 0.394, Cr 1.066 and V 0.169 was used. Differently heat-treated material was tested for tensile strength, reduction of area, elastic limit, elongation, Arnold's alternating stress, impact test, hard bending and twisting tests. Photomicrographs and cooling curves accompany the data. Comparisons with straight carbon and nickel steels are numerous.

FROM 1905 TO 1906

(38) Chromium steel. A. Brustlein. *Revue de Métallurgie*, 1905, pp. 508-515. Early manufacture at the Unieux Works (France). Production of 55 per cent ferrochromium in old crucibles was stopped when a cupola furnace at the St. Chamond Works started producing it. Steels were manufactured from 0.5 to 3 per cent Cr.

(39) Experimental evidence relating to the effect on mechanical and other properties of iron and its alloys produced by liquid air temperatures. R. A. Hadfield, *J. Iron and Steel Inst.*, No. 1, 1905, vol. 67, pp. 147-206. (Bibliography, pp. 206-220.) Results for all the common steels of Cr and Cr plus other alloying elements in chromium steels containing W, Ni, Mn, Cu and Mn:Si. No distinct effects of chromium were observed.

(40) The types of structure and critical ranges on heating and cooling of high-speed steels under varying thermal treatment. H. C. H. Carpenter. *J. Iron and Steel Inst.*, No. 1, 1905, pp. 433-473. Does not concern chromium steels as such. Photomicrographs show change in constituents by cooling from increasingly higher temperatures. At 1,100 to 1,200 deg. C. structure tended toward austenite, eventually becoming so. Tempering starts at over 500 deg. C.

(41) Recent research made upon industrial alloys and their importance. L. Guillet. *Revue de Métallurgie*, 1906, pp. 87-111. (Chrome steel, pp. 94-96.) General comments on quaternary steels, some of which contain Cr.

(42) Nickel:chrome steels. L. Guillet. *Revue de Métallurgie*, 1906, pp. 332-354. Twenty-eight Ni:Cr steels investigated. They may be pearlitic, martensitic and carbidic, of gamma iron or of gamma iron with carbides depending on the sum of C:Ni and Cr; 1.65 per cent C is equivalent to 29 per cent Ni or 18 per cent Cr. Addition of increasing amounts of Cr to a nickel steel will put it through all intermediate stages to even gamma iron and carbides. Mechanical properties of normal Cr:Ni steels can be reduced from their microstructure by comparison with nickel or chromium steels.

(43) Quaternary steels. L. Guillet. *J. Iron and Steel Inst.*, 1906, No. 2, pp. 1-142. The influence of Cr is superimposed to that of Mn in Cr:Mn steels; when Cr is sufficiently high a carbide is formed. Physical properties and microstructure depend on the sum of Cr, Mn and C being analogous to Cr:Ni steels.

(44) Chromium steel. Abstracted by *J. Iron and Steel Inst.*, 1906, No. 4, p. 926, from *Iron and Coal Trades Rev.*, vol. 73, p. 1263. Low-carbon ferrochromium is best for steel manufacture due to more even solution of carbide. Crystals of carbide cause flaws.

(45) On the art of cutting metals. F. W. Taylor. *Trans.*, Am. Soc. Mech. Engineers, vol. 28, 1906. Chromium is shown to be an essential element in modern high-speed steel.

DURING 1907

(46) The influence of chromium on the solubility of iron for carbon and the formation of graphite. Goerend and Stadeler. *Metallurgie*, 1907, pp. 18-24. Ar_3 is constant and equal to 710 deg. C. up to 21 per cent Cr; between 21 and 29 per cent Cr no such point was found. The freezing point varied from 1,130 deg. C. for 0 per cent Cr to 1,535 deg. C. for 62 per cent Cr. A small increase in Cr stops the formation of graphite by silicon. The greater the per cent of Cr the greater the per cent of C can be before the eutectic is reached. High Cr favors formation of gamma iron.

(47) The iron:chromium solutions. Trevtschke and G. Tammans. *Z. anorg. Chem.*, 1907, vol. 55, pp. 402-411. Equilibrium diagram. By rapid cooling the Fe:Cr system is a pseudo-ternary one, consisting of Fe, Cr and a compound Fe_xCr_y. The structure and properties of chromium steels depend not only on the Cr content but also upon the temperature to which they have been heated in the liquid state.

(48) The melting of Cr:Ni:Fe alloys. H. Wedding. *Stahl und Eisen*, 1907, vol. 27, pp. 1590-1591. Mobility, the formation of blow-holes and piping gases evolved, on Ni:Cr:Fe alloys.

(49) Chromium:tungsten steels. L. Guillet. *Revue de Métallurgie*, 1907, pp. 5-25. Normal steels show pearlite, martensite or carbide of Fe, Cr and W, which is found with martensite, sorbite or troostite. Ordinary structure is that of a rapidly cooled industrial steel. Physical properties depend on the class: (*a*) Pearlite steels have tensile strength and elastic limit higher, elongation and resistance to shock lower than ordinary steels; (*b*) martensite steels have very high tensile strength and elastic limit, with low values for both shock resistance and elongation; (*c*) carbide steels have low shock values—other properties are dependent on the constituent which accompanies the carbide. Hardening or quenching changes pearlitic to martensitic steels. Martensitic and carbide steels may be softened by quenching (due to gamma iron) more than straight carbon steels. Time and temperature cause solution of carbides and hence intermediate values. Heating to 1,200 deg. C. and cooling sufficiently rapidly gives an extremely fine martensitic structure with high-speed steels. Even pearlitic steels are not in use, since they cost more than Ni:Cr, which they but slightly excel. Use will, in general, be limited to high-speed tools.

(50) Concerning a new chrome tool steel. L.

Guillet. *Revue de Métallurgie*, 1907, pp. 1025-1026. A steel whose analysis shows C 2.18 per cent, Cr 14.88 per cent, Mn 0.71 per cent. Si 0.19 per cent, and P and S traces was accidentally made by adding Cr twice in a ladle. As received it consisted of pearlite and double carbide. It cannot be rolled, and is forged with difficulty. Heat to 950, cool to 850 deg. C. and oil-quench, or heat to 1,050, and cool to 950 deg. C. and oil-quench, when it becomes useful for a cutting tool for steel or iron. It does not warp during quenching.

(51) The densities and specific heats of some alloys of iron. W. Brown. *Sc. Trans.*, Roy. Dublin Soc., vol. 9, ser. 2, 1907, pp. 59-84. Chromium up to 3 per cent added to iron increases specific volume about 0.00034 c.c. for 1 per cent of added Cr. Further addition to 9.5 per cent has no effect. Chromium has very little effect on specific heat when C is relatively high.

(52) Alloy steels for motor car construction. J. A. Mathews, *J. Franklin Inst.*, 1907, vol. 167, pp. 279-397. General résumé of the author's experience.

FROM 1908 TO 1909

(53) The determination of the hardness of the constituents of iron and steel. H. C. Boynton. *Stahl und Eisen*, 1908, vol. 28, No. 1, p. 740. Hardness of pearlite varies but little with the addition of Cr, W or Mn up to 1 per cent. More than this raised the hardness.

(54) Concerning the magnetic properties of a pure iron tested by Dr. Kruesler. E. Gumlich. *Stahl und Eisen*, vol. 28, No. 2, 1908, p. 1430. Removal of gases is difficult. Effects of heating to 1,400 deg. C. on molecular structure noted.

(55) Function of chromium and tungsten in high-speed steels. C. A. Edwards. *J. Iron and Steel Inst.*, 1908, No. 2, pp. 104-132. Case-hardening the nose of a high-speed tool increases cutting speed from 13 to 14.5 per cent. Steels containing more than 3 per cent Cr and 6 per cent W show a critical range beginning at 380 deg. C. In a high-speed tool chromium forms a double carbide with W which imparts high hardness and increases the resistance to tempering.

(56) The special steels in theory and practice. Walter Giesen. The Iron and Steel Inst., *Carnegie Scholarship Memoirs*, vol. 1, 1909, pp. 1-55. Nickel: chromium steels examined for hardness, impact strength, metallography and ability to be case-hardened. Normal Ni:Cr steels may have the following structure: (*a*) Pearlite and ferrite, (*b*) pearlite and carbide, (*c*) martensite and carbide, (*d*) martensite and gamma iron, (*e*) martensite and ferrite, (*f*) gamma iron and carbide, (*g*) gamma iron. Formation of martensite depends on sum of C, Cr and Ni; the ratio of equivalence of these elements being C 1.68 per cent, Cr 18.5 per cent, Ni 28.7 per cent. Increasing Cr forms carbide. Cr:Ni steels with pearlitic or gamma iron structure can be recommended for industrial or practical use. Chromium steels containing 0 to 8 per cent Cr and 0.5 per cent C, or 0 to 5 per cent Cr and 0.95 per cent C have pearlitic microstructure and differ very slightly from carbon steels. Hardness increases with Cr independently of carbon content; brittleness is less than in plain steels with same carbon. Chromium steels containing 8 to 18 per cent Cr and 0.3 per cent C, or 5 to 12 per cent Cr and 0.95 per cent C are of martensitic or troostitic structure; have high tensile strength and elastic limit, low ductility, high hardness and medium brittleness. Chromium over 25 per cent with 0.3 per cent C or over 22 per cent with 0.95 per cent C produce very brittle alloys.

(57) Contribution to the study of steels for gears. L. M. Révillon. Iron and Steel Inst., *Carnegie Scholarship Memoirs*, vol. 1, 1909, pp. 161-217. Steels considered are divided into (1) steels containing neither Ni nor Cr; (2) Ni:Cr steels, hardened in oil or water; (3) Ni:Cr steels with high carbon capable of air-hardening; (4) high Ni steels with or without Cr. All steels were heat-treated, and tensile strength, elastic limit, elongation, reduction of area, shock strength and hardness determined. Higher Cr with a well-adjusted Ni content yields the best results with a simple treatment.

(58) Contribution to the study of special ternary steels. A. M. Portevin. Iron and Steel Inst., *Carnegie Scholarship Memoirs*, vol. 1, 1909, pp. 230-362. In steels containing 0.2 per cent C (*a*) the resistance to shear increases with Cr, but remains below 50 kg.; (*b*) steels of 7 to 13 per cent Cr have a high resistance, but low contraction on shearing; (*c*) in steels having more than 13 per cent Cr the resistance to shearing remains within 30 to 35 kg., but contraction increases and elastic limit under shear decreases. In steels containing 0.8 per cent C (*a*) and with 5 per cent Cr have high resistance and elastic limit in shear, but contraction is low; (*b*) steels having 7 to 14 per cent Cr have uniform resistance to shear; (*c*) steels containing over 18 per cent Cr show a decrease in resistance and elastic limit in shear, while contraction increases.

(59) Special steels. Léon Guillet. Abstracted by *Iron Age*, vol. 84, 1909, pp. 916-917, from report read at Fifth Congress of the International Association of Testing Materials at Copenhagen, Denmark, Sept. 7-11, 1909. Tendency of alloying is to raise mechanical strength, simplify thermal treatment and create special anti-friction steels. Analysis, mechanical properties and heat-treatment of one Ni:Cr:V and one Ni:Cr steel are given. Several Cr and Cr:Ni steels can be air-quenched. Anti-friction steels contain Cr 0.42 to 0.54, Ni 2.43 to 2.6 and C 0.33 to 0.62.

DURING 1910

(60) Thermal treatment of special steels. Léon Guillet. *Revue de Métallurgie*, 1910, pp. 489-495. General discussion dividing steels into (1) pearlitic, (2) martensitic, (3) "polyhedrique"—i.e., steels having high percentage of alloy element in solution in gamma iron; (4) carbide steels having a single or double carbide, not necessarily in solution.

(61) Chrome steel permanent magnets. W. Brown. *Sc. Proc.*, Roy. Dublin Soc., new series, vol. 12, 1909-10, pp. 349-353. Results on seven steels giving chemical composition and magnetic moment per gram when glass hard and annealed. Annealing has little effect on magnetic moment; 1.95 per cent Cr, 0.86 per cent C gives the best magnet. Discusses previous investigations.

(62) Some physical properties of 2 per cent chromium steels. H. McWilliams and E. J. Barnes. *J. Iron and Steel Inst.*, 1910, No. 1, pp. 246-267. The forged material was normalized, annealed, quenched in water and drawn at 400 deg. C., 550 deg. C. and 700 deg. C. respectively and tested. Carbon varied from 0.2 per cent to 0.85 per cent in six different steps. A thermal and microscopic analysis is presented.

(63) The A_2 point in chromium steel. Harold Moore. *J. Iron and Steel Inst.*, 1910 No. 2, pp. 268-275.

Critical ranges determined by Carpenter and Keeling's method. Magnetic change point curves also plotted. Ac_1 is progressively raised by Cr. Identity of the lower critical point with magnetic changes proves it to be Ac_{2-3}. Occurrence of Ac_2 below Ac_1 means that Fe_3C is insoluble in beta iron.

(64) Concerning two nickel:chrome steels. M. A. Portevin. *Revue de Métallurgie*, 1910, pp. 808-810.

Chemical Analysis	C	Si	S	P	Mn	Ni	Cr	Microhms per c.c.
Steel *A*.....	0.19	0.18	0.02	0.01	0.44	2.53	0.63	26.2
Steel *B*.....	0.19	0.17	0.02	0.01	0.53	2.69	0.64	32.2

The slight difference in composition cannot cause such a difference in resistance. In other steels a difference of 3.52 per cent Ni caused similar results. Photomicrographs show very dissimilar structure in *A* and *B*, due to the effect of previous thermal treatment both in liquid and in solid state.

(65) Report on the wear of steels and their resistance to crushing. Felix Robin. Iron and Steel Inst., *Carnegie Scholarship Memoirs*, 1910, vol. 2, pp. 1-265. (Cr steels 41, 152, 166.) Double carbide in Cr steels increases wear resistance, especially where the carbide is in numerous grains surrounded by fine martensite, as in annealed steels containing 2 per cent Cr. Cr:W steel is strongest against crushing among Cr, Cr:Ni and Cr:W steels. The straight Cr steel has the greatest interstrain hardness.

During 1911 and 1912

(66) The chemical and mechanical relations of iron, chromium and carbon. J. O. Arnold and A. A. Read. *J. Iron and Steel Inst.*, 1911, No. 1, vol. 83, pp. 249-260, and discussion, pp. 260-268. Brief résumé of several previous investigations; analysis, manufacture and physical properties are listed.

(67) Case-hardening chromium steels. F. Giolitti and F. Carnevali. Abstracted by *J. Iron and Steel Inst.*, 1912, No. 284, p. 595, from *Atti della Reale Accademia delle Scienze di Torino*, vol. 46, pp. 409-432. A 2.3 per cent Cr steel was carbonized using CO, ethylene, and CO and charcoal, giving similar results to carbon steels. Cr causes an increase in the maximum carbon concentration of the carbonized zone.

(68) Contribution to the study of iron:chromium alloys, with special reference to their solubility in acid. Phillip Monnartz. *Metallurgie*, 1912, pp. 161-176 and 193-201. A treatise on solubility.

(69) Relations between the macrostructure and the crystallization of steel. M. N. T. Belarew. *Revue de Métallurgie*, 1912, 647-680. The kind of steel is quite incidental to the relation of crystalline structure to macrostructure.

(70) Various acoustic properties of steel as a function of their temperatures. Felix Robin. *Revue de Métallurgie*, 1912, pp. 413-470. Chromium and Si act more energetically than Mn and Ni in retaining vibrations. In alloy steels the duration of sound is in general raised by Cr.

(71) The corrosion of Ni, Cr and Ni:Cr steels. J. N. Friend, J. L. Bently and W. West. *J. Iron and Steel Inst.*, 1912, No 1, pp. 249-258. Corroding media, tap water, seat water, hot water and dilute H_2SO_4 may be divided into two groups—acid and neutral. Acceleration tests with H_2SO_4 are misleading. There is an optimum concentration of Cr for resistance to attack. In neutral media corrosion resistance rises with Cr.

(72) Magnetic properties of special steels. O. Boudouard. Abstracted by *J. Iron and Steel Inst.*, 1912, No. 1, vol. 85, p. 575, from (*a*) *Compt. rend.*, vol. 153, pp. 1475-1478, (*b*) *Revue de Métallurgie Memoirs*, vol. 9, pp. 294-303. In carbon steels the electric resistance increases with carbon, while in the Cr steels irregularities appear to have no relation to carbon.

(73) The magnetic properties of a variety of special steels at low temperature. J. G. Gray and A. D. Ross. *Trans.*, Faraday Soc., vol. 8, 1912, pp. 115-134. Studies of two steels containing 1 and 4 per cent Cr respectively.

(74) Chromium:vanadium steel tires. Abstracted by *J. Iron and Steel Inst.*, part 1, 1913, p. 665, from *Iron Trade Rev.*, 1912, vol. 51, pp. 1217-1218. Tables showing physical properties and chemical composition of heat-treated Cr:V steels. After 121,000 miles a locomotive still had its Cr:V tires in good condition, while carbon steel tires require turning after 60,000 miles.

(75) Concerning chromium steels. M. Portevin. *Compt. rend.*, No. 153, 1911, pp. 64-66. Reports on hardness and microscopy of two high-chromium steels heated to 1,300 deg. C. and cooled in the furnace.

During 1913 and 1914

(76) On the transformation points and the structure of nickel:chrome steels. Léon Guillet. *Compt. rend.*, No. 156, 1913, pp. 1774-1776. Tabulates sixteen Ni:Cr steels, the best of fifty samples. Shows transformation points on heating and cooling, chemical composition and structure. The addition of Cr to a Ni steel caused effects depending on the percentage of Ni and C.

(77) Differences between the structure and the composition of certain steels. M. Bres. *Revue de Métallurgie*, 1913, pp. 797-808. Report on four Ni:Cr steels having almost identical compositions, but different microstructure and mechanical properties. Different structures were caused by different casting practice and could not be removed by heat-treatment or work, but behaved as steels of their kind after hardening and tempering. These structures correspond perfectly with the corresponding mechanical properties. Control of the factors influencing such special structures would permit making different steels of the same composition.

(78) The magnetism of permanent magnets. Silvanus F. Thompson. *J. Inst. Electrical Eng.*, vol. 50, 1913, p. 217. Includes a bibliography of magnetism which covers many chromium steels.

(79) The corrodibility of nickel, chromium and nickel:chromium steels. J. N. Friend, W. West and J. L. Bently. *J. Iron and Steel Inst.*, No. 1, 1913, vol. 92, pp. 388-398. Nickel steels appear to resist corrosion very well for some time and then fail rapidly. A 20 per cent Cr steel is very resistant to acid corrosion.

(80) New researches upon the transformation points and the structure of nickel:chrome steels. Léon Guillet. *Compt. rend.*, vol. 158, 1914, pp. 412-414. Presents tables for 2 and 4 per cent nickel steels with different percentages of C and Cr, giving transformation points, structure, chemical analysis, hardness and resilience.

(81) High-speed steels. M. Denis. *Revue de Métallurgie*, vol. 11, 1914, pp. 4-94. A study of the cutting properties and their practical utilization.

(82) Studies upon the general properties of high-speed steels. M. Denis. *Revue de Métallurgie*, No. 6, 1914, pp. 569-669. General test methods for high-speed steels and the best treatment which can be applied.

(83) Permanent magnetism of certain chrome and

tungsten steels. M. B. Moir. *Phil. Mag.*, sixth series, vol. 28, 1914, pp. 738-748. Steel containing 8 per cent Cr showed a 5.5 per cent loss, against 2.8 per cent loss for 16 per cent Cr steel, but the former had a higher residual magnetism, so that it remained a stronger magnet.

(84) The magnetic properties of a graded series of chrome steels at ordinary and low temperatures. M. B. Moir. *Phil. Mag.*, vol. 27, 1914, pp. 830-842. Six chromium steels containing Cr 1 to 20 per cent were tested at 15 deg. C. and —190 deg. C. in forged and rolled condition after annealing and after quenching from 900 deg. C. Lowering the temperature diminished the susceptibility for low and increased it for high fields. The magnetizing field at which curves corresponding to 15 deg. C. and —190 deg. C. respectively crossed increased with Cr content up to 12 per cent in annealed specimens and then decreased.

(85) Magnetic habits of alloy steels. J. A. Mathews. *Proc.*, Am. Soc. Testing Materials, vol. 14, 1914, part 2, pp. 50-66. Dwells on chromium steel only as it is the universal magnet steel. Magnetic hardness might be measured by the ratio of residual density and coercive force. Relation of Brinell hardness to magnetic hardness is given.

(86) Chromium: vanadium steel wheels. Abstracted by *J. Iron and Steel Inst.*, 1914, No. 1, p. 372, from *Iron and Coal Trade Review*, 1914, vol. 89, p. 544. Particulars are given of results of different types of tender wheels on the Grand Trunk Railway.

(87) Cr: V rolled steel wheels. Abstracted by *J. Iron and Steel Inst.*, 1914, No. 2, p. 711, from *Iron Age*, vol. 92, p. 1106. In the drop tests, 896,000 ft.-lb. imposed before cracking or breaking; fractured tough and stringy fracture; steel uniformly hard. Analysis Cr 1 per cent, V 0.16 to 0.20 per cent and C 0.55 to 0.65 per cent.

(88) Mayari steel, its properties and uses. The Pennsylvania Steel Co. *Iron Age*, vol. 89, 1914, pp. 69-72. The steel is made with C up to 1.5 per cent. S and P are below 0.04 per cent and Mn is as desired. Nickel averages 1.25 per cent, while chromium runs 0.2 to 0.4 in one grade and 0.4 to 0.7 in the other. It is manufactured in the same manner as a straight carbon steel. It is difficult to weld. Commercial grades and uses are given, also some curves showing effect of heat-treatment.

During 1915 and 1916

(89) The corrosion of high Cr steels, Robert Hadfield. Abstracted by *Iron Age*, vol. 97, 1916, pp. 202-203, from Faraday Soc., 1915D. Compares various steels to high-chromium and stainless steel. Mechanical properties of stainless steel are given. High Cr steels are usually more resistant than most alloy steels and much more so than straight carbon steels.

(90) The thermo-electric properties of special steels. E. L. Dupuy and A. M. Portevin. *J. Iron and Steel Inst.*, 1915, vol. 91, pp. 306-336. Chromium has less influence than nickel.

(91) The effect of chromium and tungsten upon the hardening and tempering of high-speed tool steel. C. A. Edwards and H. Kikkawa. *J. Iron and Steel Inst.*, 1915, No. 2, vol. 92, pp. 6-31. Determines Brinell hardness after various temperings, using a constant rate of cooling. Chromium and carbon cause the greatest hardness, and lower the temperature at which hardening occurs. Curves of specific gravity vs. tempering temperature and Brinell hardness vs. tempering temperature are similar and show great hardness for highest volume.

(92) Concerning the allotropic transformation and the microstructure of nickel: chrome steel. A. M. Masloff. *Revue de la Soc. Russe de Métal*, vol. 1, pp. 494 and 515, 1915. Abstracted in *Revue de Métallurgie*. Extracts, 1918, pp. 37-44. Chromium retards decomposition of austenite. A low Ni steel with enough Cr can be air-hardened. Cr increases homeogeneity and hardness.

(93) Note on the relations between cutting efficiencies of tool steels and their Brinell or scleroscope hardness. J. O. Arnold. *J. Iron and Steel Inst.*, 1916, No. 1, pp. 102-104. Brinell or scleroscope hardness are useless for estimating the thermal stabilities of hardenites, the main cause of lathe efficiency.

(94) Initial temperatures and critical cooling velocities of a chromium steel. C. A. Edwards, J. M. Greenwood and H. Kikkawa. *J. Iron and Steel Inst.*, 1916, pp. 114-140. Steel contained 6.15 per cent Cr, 0.63 per cent C, 0.7 per cent Mn. Chromium imparts the property of self-hardening which in turn is governed by the rate of cooling.

(95) The transformation of special steels at high temperature. R. Honda, K. Tawara and H. Takagi. *J. Iron and Steel Inst.*, 1916, No. 1, pp. 1 and 244-254. Heating, cooling and magnetization curves are taken for the six alloy steels below, and results tabulated.

Steel	C	Si	Mn	P	S	Cr	W	V	Mo
1 D.S.W. steel	1.16	2.89	0.4	0.047	0.038	2.74	....	.....	....
2 Ultra capitol	0.66	0.08	0.08	0.018	0.016	3.43	16.81	.....	....
3 New capitol	0.64	0.05	0.01	0.015	0.012	3.73	14.63	0.011	....
4 Bohler	0.82	0.18	0.26	0.003	0.016	3.71	14.63	0.20	0.17
5 Super-rapid Novo steel	0.59	0.22	0.06	0.028	0.23	2.86	18.81	....	....
6 Becker diamond	1.05	0.16	0.35	0.009	0.012	....	3.17	....	....

In the cooling curves the critical point remains almost constant but A_3 coincides with A_2. Cooled from 1,000 deg. C. or higher, the A_3 transformation is displaced partly or wholly to a lower temperature (400 deg. C.).

(96) Manufacture and uses of alloy steels. H. D. Hibbard. *Bull.* 100, Bureau of Mines, pub. 1916, 72 pages. Brief notes on heat, manufacture, use, methods of treatment and physical properties. Steel containing Cr, Cr: Ni, Cr: V and high-speed steels are discussed.

(97) The critical points of self-hardening steels and of the formation of troostite and martensite. M. P. Dejean. *Revue de Métallurgie*, 1917, pp. 641-676 (chromium steels, pp. 661-666). Among self-hardening steels are the following: Cr, Ni:Cr, Cr:W, Ni:Cr:Cu. A series of cooling curves are obtained by varying the initial temperature and rate.

During 1917

(98) Some observations relative to the transformation points of special steels. Leon Guillet. *Revue de Métallurgie*, 1917, pp. 676-683. Analysis, transformation points, structure and physical properties of two series of Ni:Cr steels. The first of these steels contains approximately 2 per cent Ni, C 0.15 to 0.34 per cent and Cr 0.06 to 10.25 per cent; the second, C 0.07 to 0.27 per cent, Ni 4 per cent and Cr 0 to 13.87 per cent. Cr has little effect upon the transformation points on cooling between 3 and 5 per cent.

(99) Concerning the transformation of nickel: chrome steels. M. A. Portevin. *Revue de Métallurgie*, 1917, pp. 707-716. This work is divided into (*a*) methods of thermal analysis, (*b*) influence of thermal

treatment on transformations, (*c*) correlation of microstructure. Ar, microstructure and hardness of a Cr:Ni steel are dependent on (1) chemical composition and initial structure, (2) rate of cooling, (3) temperature of heating, (4) pouring conditions.

(100) The penetration of the hardening effect in chromium and copper steels. L. Grenet. *J. Iron and Steel Inst.*, 1917, No. 1, pp. 107-117. Results rather than experimental data. High-chromium steels not containing Cu air-hardened with difficulty. Cr, Cu, Ni or Cu:Cr steels may be air-hardened. Copper does not prevent softening or annealing at high temperatures, but increases the depth of hardening.

(101) Chromium steels for magnets. E. Gumlich. Abstracted by *J. Iron and Steel Inst.*, 1917, No. 1, p. 411, from *Mitteilungen a.d. Physikalisch-Technische Reichsanstalt.* Tungsten having become unobtainable in Germany, chromium was used as a substitute.

(102) The influence of heat-treatment on the electrical and thermal resistivity and thermo-electric potential of some steels. E. D. Campbell and W. C. Dowd. *J. Iron and Steel Inst.*, 1917, No. 2, pp. 251-265. Two chromium steels are included in set. All explanations are advanced in terms of solution theory.

(103) The constitution of the iron:chromium alloys. Ernest Jäneck. *Z. Elektrochem*, vol. 23, 1917, pp. 49-55. Investigation of Fe:Cr alloys by cooling curves and microscope. Equilibrium diagram shows the metals completely soluble in the liquid and partly soluble in the solid state or a ternary system of Fe, Cr and Cr_xFe_y. The eutectic point is 75 per cent Cr, 25 per cent Fe, temperature 1,320 deg. C. The first solid solution is up to 55 per cent Cr and the second from 100 to 85 per cent Cr. Previous investigators used thermit mixtures and formed high-melting $AlCr_4$.

(104) Physiochemical properties of Cr:Ni steel. H. J. French. MET. & CHEM., vol. 17, 1917, pp. 473-476. Properties which may be developed by the heat-treatment of certain chromium:nickel steels are recorded.

(105) Topical discussion on the use of several alloying elements in alloy steel. *Proc.*, Am. Soc. for Testing Materials, vol. 17, part 2, 1917, pp. 5-58, by F. J. Griffiths (chrome:vanadium steel, pp. 33-45). Four Cr:V steels are tabulated, giving different heat-treatments, physical properties and the difference between Ar and Ac. Results obtainable in routine commercial practice are quite uniform.

(106) The rôle of chrome:vanadium steel. R. J. Griffiths. *The Michigan Technic*, vol. 30, No. 3, 1917. A boost for Cr:V steel.

(107) The influence of chromium in steel. R. J. Anderson. *Iron and Coal Trades Rev.*, October, 1917, vol. 95, p. 439. Abstracted by *J. Iron and Steel Inst.*, 1918, No. 1, vol. 97, p. 546. Chromium does not act as a scavenger, nor does it confer soundness. In small amounts it increases tensile strength without reducing ductility; excessive amounts cause brittleness.

DURING 1918

(108) On the magnetic analysis of carbides found in different kinds of steel. T. Ishiwara. *Science Reports*, Tohoku Imperial University, first series, vol. 6, No. 5, 1918, pp. 285-294. The double carbide residue of a Cr steel and high-speed tool steel are paramagnetic, while Fe:Mn, Fe:W double carbides are magnetic and decompose at high temperatures. The decomposition of carbides into their components occurs between 650 and 730 deg. C. Residues show the presence of magnetite. Separation of cementite from eutectoid austenite on tempering begins at about 130 deg. C and ends at 380 deg. C. Temperatures of 130 deg. C., 360 deg. C. and 600 deg. C. correspond to martensite, troostite and sorbite respectively. Residue from quenched specimen contains only a small quantity of cementite, but its amount increases with the tempering temperature until it reaches 360 deg. C.

(109) On the structure of iron:carbon:chromium alloys. T. Murakami. *Science Reports*, Tohoku Imperial University, first series, vol. 7, No. 2, 1918, pp. 219-276 and twenty plates. This investigation forms the subject of the twenty-fourth report of the Alloy Research Institute. The author uses magnetic, thermal and microscopic methods in his work.

(110) Researches upon high-speed steel made at the Harvard Laboratories. M. Yatesevitch. *Revue de Métallurgie*, 1918, pp. 65-115. (Bibliography.) Deals with high-speed steels rather than Cr steels.

(111) Chromium. Samuel H. Dolbear. *Mineral Industry*, vol. 27, for 1918. (Bibliography.). Annual figures relative to price, importation and supplies of chromates and other chromium-containing products.

(112) The metallography and heat-treatment of metals used in airplane construction. F. Grotts. CHEM. & MET. ENG., vol. 19, 1918, Nos. 4 and 5. Studies chromium:nickel steel (p. 195), chromium:vanadium steel (p. 241) and a special chromium steel (p. 246) analyzing 0.24 C, 0.36 Mn, 0.013 S, 0.020 P, 0.30 V and 10.44 Cr.

DURING PART OF 1919

(113) The manufacturing and working of high-speed steel. J. H. Andrew and G. W. Green. *J. Iron and Steel Inst.*, 1919, No. 1, vol. 99, pp. 305-344. Practical application of scientific methods to high-speed steel practice. These steels anneal readily if heated above critical range and slowly cooled through the lower critical point. The steel should not be heated over 1,320 deg. C., best results being obtained using temperatures from 1,300 to 1,320 deg. C. The highest secondary hardness (Brinell 610) is developed by heating between 550 and 600 deg. C. Hot work must destroy carbide envelopes occurring in the form of loops and hooks; an 88 per cent reduction on a 6-in. square ingot is necessary.

(114) The molecular constitution of high-speed steels and their correlation with lathe efficiencies. J. O. Arnold and F. Ibbotson. *J. Iron and Steel Inst.*, 1919, No. 1, vol. 99, pp. 407-435. Twelve per cent V increases efficiency of tool 98 per cent, and it can be used after a water-quench from 1,300 deg. C. Hardness and lathe efficiency are by no means identical terms.

(115) Heat-treating Cr:Ni steel with special reference to impact testing. R. C. Loudenbeck. Steel Treating Research Soc., vol. 11, No. 5, 1919. Izod impact tests plotted against strength, yield point, elongation, reduction of area and Brinell hardness, showing an increase in impact value with a drop in tensile strength (136,000 to 125,000 lb. per sq.in.) and elastic limit (115,400 to 103,000 lb. per sq.in.), while the greater the elongation and reduction of area the greater the impact value. Brinell numbers vary inversely with impact. As a rule the basic steel gave better impact figures with a given set of other physical properties than did the acid steel.

New Variable Speed Power Transmission System

A SPEED control system suitable for a wide variety of uses for which variable speed power transmission is needed has been marketed by the Oilgear Co., of Milwaukee. It consists essentially of a pump which can be adjusted through a wide range of delivery capacity, and a motor driven by the work fluid—oil—received from the pump. The Oilgear variable speed drive receives power from a constant speed source, such as a line shaft, gasoline or oil engine, or constant speed electric motor, and delivers this power at any required speed from zero to a maximum in either direction, at an efficiency at full load of 85 per cent.

An infinite series of definite speed ratios irrespective of variations in load may be obtained, and there are no losses in accumulators, wire drawing through valves, etc. The power used to drive the variable stroke pump is always proportional to the power actually used by the variable speed motor. High torques are obtained at low speeds without additional power input.

The Oilgear variable speed transmission is adapted for such drives as lathes, drill presses, boring machines, etc., and machinery used in textile mills, powder mills, laundries, paper mills, cement plants and rubber mills. It is also admirably adapted to automatically controlled stokers, conveyors, gasoline cranes and excavating machinery, and to many drives where electric motors and gasoline engines are not inherently suited.

MECHANISM

Fig. 1 illustrates the motor end with the motor unit removed and shown to the left. The pump unit is identical except that it is cradled and its axis may be moved to right or left, thereby varying its displacement.

The cylinder barrel of either unit consists of a hub with central bore and five cylinders radiating therefrom. The bore of the hub is fitted closely around a ported pintle and each of the radiating cylinders contains a plunger, operated by a flat steel crosshead (hardened and ground), and delivering the plunger thrust through a roller bearing to a reaction plate on the surrounding driver. These parts are all shown at bottom of Fig. 1. As the cylinder barrel revolves each cylinder in turn registers with one of the ports as the plunger in that cylinder is moved outward, and after passing through a half revolution the same cylinder begins to register with the other port and continues to do so while the plunger is moving inward. Therefore each cylinder draws in a quantity of oil from the upper port and expels the same amount of oil into the lower port. The amount of oil handled by each cylinder at each revolution depends upon the stroke. If the operator sets the stroke at zero, no oil will be pumped. If the pump is at maximum, a large and perfectly steady flow of oil is drawn in through one of the ports and delivered through the other.

Each of these two ports communicates with a lengthwise passage through the interior of the pintle, terminating in a similar port at the opposite end of the pintle inside the case in Fig. 1. This is the motor pintle, and upon it is mounted the motor unit as described above. The oil issuing from one of the ports within the motor cylinder barrel pushes the plungers outward with whatever force may be necessary to compel the motor to rotate, and as each successive plunger reaches its outermost position, it ceases to register with the pressure port, crosses a bridge, and expels the oil into the return or low pressure port during the succeeding half of its revolution. Thus the five motor cylinders combine to return the perfectly steady stream of oil through the low pressure passage to be pumped over again back to the motor.

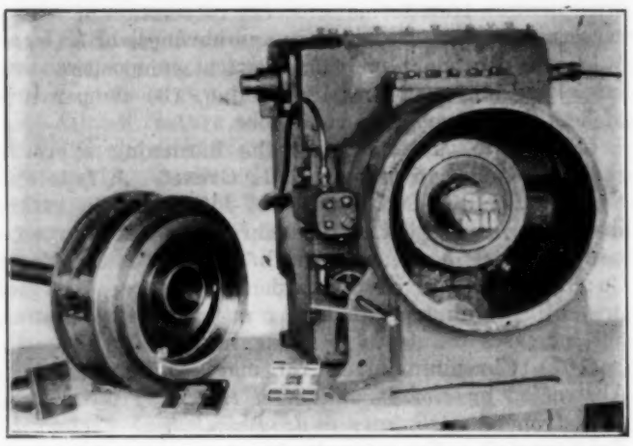


FIG. 1. MOTOR END OF OILGEAR VARIABLE SPEED DRIVE

Besides the positive driving qualities of the Oilgear transmission and its perfect control of speed ratios, there is automatic protection against overload. The speeds selected by the operator are obtained irrespective of changes in load, unless the load becomes excessive, in which case an automatic overload gear relieves the operator of responsibility by preventing him from overloading the machine. The overload gear may be adjusted to any desired maximum load up to the capacity of the machine.

Boiling Linseed Oil With Electric Heat

Difficulties, disastrous fires and explosions have occurred in many cases in connection with the problem of boiling linseed oil, especially when it is used in connection with the production of linoleums and oilcloths.

F. J. Ryan & Co., Wesley Bldg., Philadelphia, Pa., has completed both the installation and test of a new boiling method using electric heat, which besides doing away with the distinct disadvantages of the old method has made possible complete heat and chemical control over a very wide range of temperatures involved.

This installation was made at the works of the Armstrong Cork Co., Linoleum Section, Lancaster, Pa. The installation is of considerable size, having a connected load of 75 kw. and handling batches of 2 tons of material at each heat. In approaching the problem it was necessary to consider the inherent characteristics of linseed oil to build up heat within itself during the oxidation period, and the fact that viscosity changes materially within very narrow temperature range, necessitating definite and exacting control.

The heating method applied is indirect and therefore the temperature of the ribbon is necessarily considerably higher than that desired in the oil. This necessitated a special cooling system to reduce the exterior heat to the normal oil requirement, when stopping the furnace to hold for processing.

General Electric heating units and Leeds & Northrup control are used, while the main furnace body and appliances for operating were constructed at the works of the Lancaster Iron Works, Lancaster, Pa., which is associated with the Ryan company.

Book Reviews

HEAT-TREATMENT OF SOFT AND MEDIUM STEELS. By *Federico Giolitti*, Bessemer Medalist. Translated from the Italian by E. E. Thum, Associate Editor, CHEMICAL & METALLURGICAL ENGINEERING, and D. G. Vernaci, Metallurgical Engineer; 374 pp., 6 x 9; 214 illus. Price $5. New York: McGraw-Hill Book Co., Inc.

Dr. Giolitti's book is probably unique in its field, in that the author has set himself the task of writing a treatise for the use of practical men which explains, as fully as the present state of metallurgical knowledge permits, the mechanism of the solidification of steel, in order that the reasons for the different heat-treatments described may be truly understood by the reader. In a general way, every one who practices heat-treatment understands that heatings above the critical range and below the solidus promote diffusion of the carbon and other elements in the steel, and hence are the first step necessary in heat-treatment, their function being to substitute homogeneity for its opposite in both forged and rolled steels. We all realize, too, that to retain the homogeneous state attained during this first heating comparatively rapid cooling is essential, and that to relieve the stresses set up and to reduce the hardening due to this rapid cooling a second heating is necessary, generally at a temperature below the critical range.

Of the 360 text pages of the book, the first 101 are devoted to a discussion of the phenomena of solidification and of transformation of the freezing and cooling steel, and an attempt is made to show and explain diagrammatically the reasons for and the extent of the heterogeneities of chemical and physical composition resulting from solidification of the metal and its transformation in cooling through the critical range. The author is not content with diagrams in two dimensions, but soon carries his reader into three, and even into more complicated figures in which by a sort of process of compromise the steels containing four, five or more variables can be reduced to a three-dimension diagram.

This part of the book is very heavy reading and quite beyond the mental grasp of a great many, perhaps a majority, of so-called "heat-treaters"—indeed no one but a thoroughly trained theoretical metallurgist could follow the explanations intelligently. Inasmuch as our present knowledge is still not nearly complete enough to allow numerical values and definite locations to be assigned to these various curves and surfaces, one is tempted to ask oneself if after all the effort to follow all this complicated reasoning has been worth while. Indeed, the author himself is apparently troubled by the same doubts.

Having, in parts I and II, chapters 1 to 10, covered these purely theoretical considerations, the author proceeds, in part III, chapters 11 and 12, to discuss the selection of the heat-treatments best suited to break up the initial heterogeneity of the steel, and to explain somewhat in detail the reasons underlying such selections, these chapters, as indeed is true of all the rest of the book, frequently referring back to discussions contained in the first two sections. Chapter XIII then discusses two groups of phenomena which modify the effects of these heat-treatments that are designed to reduce heterogeneity (for which the author has coined the phrase "preliminary" heat-treatments, as contrasted to the subsequent heatings to lower temperatures, which he styles "final" or "quality" heat-treatments). These two groups of phenomena are those arising during rolling, forging, etc., and those due to solid non-metallic inclusions.

In this chapter we learn the disquieting fact that steels containing certain classes of inclusions cannot be heat-treated in such a way as to make them the equal of metal free from these undesirable parasites. The underlying cause of this is stated to be "the state of oxidation in the system, or better, the oxygen pressure of the non-metallic particles and of the metal respectively, and from the variations which this ratio suffers during crystallization and the subsequent cooling." A series of experiments, the author states, makes this fact practically certain, and for the description of these experiments one is referred to Italian work and to a forthcoming article in CHEMICAL & METALLURGICAL ENGINEERING. It is unfortunate that these data should not have been included in the present volume, as the mere statement of fact leaves the reader who has not read the articles in question unconvinced. Examples are given showing the connection between inclusions and "streaked" or "woody" fractures in transverse test-bars of forged steel. In later chapters this subject is taken up again, when considering transverse strength.

In part IV, chapters 14 to 18 inclusive, the heat-treatment of cast steel is discussed in great detail. Perhaps the most interesting part of these chapters is that which explains the relationship between the primary or dendritic structure and the secondary or network structure of cast steels. It is shown that while the latter structure can be broken up by comparatively simple heat-treatments, the primary or dendritic structure is very persistent and can be broken up only by repeated heatings and coolings. It is shown also that although a fibrous fracture, indicating considerable toughness, is produced in tension specimens by the more simple treatments which break up only the ferrite network, in the impact tests only the specimens that have undergone the more complex treatments designed to break up the dendritic structure show a fibrous fracture.

The arrangement of these tables of tests and heat-treatments is not good, as the reader is constantly forced to refer back a number of pages in order to refresh his memory as to the heat-treatments to which the various specimens in the tables of tests have been subjected. To the metallurgist who is familiar with the heat-treatment of cast steel, too, there appears to be far too wide a gap between the two classes of heat-treatments described—the simple ones that do not affect the dendritic structure, and the complex ones that do. It is by no means clear, and indeed in the reviewer's opinion is not a fact, that recourse need be had to such complicated and drastic treatments to attain this desirable effect.

The very interesting fact is brought out in these chapters that in very low-carbon cast steels the dendritic structure is only slightly developed, so that quite simple heat-treatments suffice to give these steels comparatively good physical properties. Further, it is shown clearly and convincingly that medium-carbon cast steels cooled slowly after the preliminary annealing develop a coarse microstructure and correspondingly poor physical properties, indicating the desirability of more rapid cooling, as in air, oil or water, followed by proper reheating, if the best physical properties are to be attained.

An important discussion in these chapters is that in which it is shown that cast medium-carbon nickel steels develop this coarse microstructure on cooling after the preliminary heat-treatment far less readily than do simple steels, so that an air-cooling of the nickel steel is roughly the equivalent of a quenching of the carbon steel—a fact of great importance in the heat-treatment of castings of large size. Many data are given showing the excellent physical properties that can be obtained with mild nickel steel castings suitably heat-treated.

Unfortunately, though the author does not hesitate to give many pages of data and tests showing the truly remarkable results attained in the Italian plant with which he is connected in the manufacture of these castings, he does not feel at liberty to reveal the exact heat-treatments to which the various castings described were subjected in order to give them these fine physical properties. This seems a most unfortunate omission, as it looks far too much like boosting the goods of a foreign maker in a scientific treatise.

Chapter 18 is devoted to the effect of non-metallic impurities upon the behavior of cast steel in heat-treatment, and we are again reminded that badly made steel does not respond properly to even the most scientific heat-treatment —the explanation, as before, being couched in more scientific language.

Part V, chapters 19 to 22 inclusive, deals with the heat-treatment of rolled and forged steels. Consideration is given to the manner in which preceding hot-work modifies the effect of heat-treatment upon the steel; and the close connection between lamellar structure in rolled steels, which

gives rise to transverse weakness and ingotism in cast steels, is pointed out. The same heat-treatments, therefore, that will eliminate ingotism in cast steel tend to improve the properties of rolled or forged steel, especially when tested transverse to the direction of rolling. Mention is made also of the marked effect of cold-work upon subsequent heat-treatment, due to grain growth during the annealing.

Tables and data are given and discussed showing that forging before heat-treatment is of less value in the case of steels of compositions suited to use as castings than in the case of other compositions not suitable for cast steel. A very interesting section is devoted to the effects of heat-treatment on pieces of steel of large mass, and the author points out the desirability of using for these heavy forgings steels whose transformation points are lowered and whose thermal hysteresis is increased by the use of suitable alloys. In the case of certain of these alloy steels, heavy forgings can be heat-treated without rapid cooling and yet show fine microstructure and good physical properties throughout their cross-section, whereas ordinary steels so treated retain in their inner portions a very coarse microstructure, with correspondingly poor physical properties. This is, of course, of great value in the case of forgings so heavy that they cannot be quenched without liability of cracking.

The last two chapters, in which are considered the effects of heat-treatment upon the longitudinal and the transverse properties of steel, are perhaps the most interesting part of the whole volume.

Data are given to show the desirability of using alloy steels that can be heat-treated without quenching with results practically as good as those obtained by quenching of simple steels, a procedure that enables the steel maker to give first class physical properties to forgings and to castings of such shape and design as to make quenching dangerous. The great difference between the longitudinal and the transverse properties of rolled steels is discussed at length, and the difficulty of so heat-treating rolled and forged steels as to obtain really good transverse properties is emphasized. Mention is made also of the importance of so designing vital parts and so carrying out the forging of them as to prevent their being subjected in service to heavy stresses in a direction transverse to the direction of forging. The reader is again reminded of the virtual impossibility of so heat-treating steel containing certain kinds of inclusions that it will show really good properties when tested transverse to the direction of rolling or forging, and the book concludes with the following paragraph, which at first sight sounds revolutionary, though after carefully reading the whole work its truth appears undeniable:

"It follows that in many cases, and above all when it is impossible to forge the piece in such a way that the working stresses fall in a longitudinal sense, *the rational employment of heat-treated steel castings may present relevant advantages in comparison with steel forgings*, not only from the viewpoint of rapidity of construction but also of resistance to stresses and its immunity from accidental fragility." (The italics are the reviewer's.) To one who, like the reviewer, has preached for years the advantages of real heat-treatment of steel castings for severe service, this paragraph brings a peculiar satisfaction.

The volume includes a brief bibliography of books bearing upon the subject under discussion, and references to other books and articles by the author, some of which give in more detail the discussions necessarily abbreviated in the present volume.

The work of translation has been ably done, so that in no instance has the sense of a paragraph or sentence been obscured. It is embarrassing, however, to the American reader to have the dimensions of castings and forgings given almost in every case in metric figures. With this exception and the above-mentioned fault in the arrangement of some of the tables of heat-treatments and physical properties, the presentation of the data is extremely good.

The work should be of the greatest value to the technically trained metallurgist, and though a good deal of the purely theoretical matter is probably beyond the grasp of the practical heat-treater, yet he too can obtain much most valuable information from the detailed discussions of the various heat-treatments.

JOHN H. HALL.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Platinum Substitute.—James B. Grenagle, of Catonsville, Md., has patented an alloy which is claimed to be adapted for use in laboratory apparatus and for other chemical and electrochemical purposes for which platinum is commonly used. The alloy contains 60 to 90 per cent of molybdenum and 40 to 10 per cent of tantalum; it has a melting point above 2,000 deg. C., has a high tensile strength, is ductile and malleable, and is highly resistant to the action of ordinary chemical reagents. (1,385,072; assigned to the Rare Metals Reduction Co., of Baltimore, Md.; July 19, 1921.)

Nitrostarch Explosives.—In the production of nitrostarch, as with other explosives, it is desirable to obtain great strength with a maximum insensibility to blows or friction. It is known that the explosive strength of nitrostarch is not materially decreased by the presence of a limited amount of water, and, in fact, owing to the intense heat produced at the instant of explosion, this water actually serves to increase the volume of gas which is produced. In order to prevent evaporative drying of the wet nitrostarch, Walter O. Snelling, of Allentown, Pa., assignor by mesne assignments to the Trojan Powder Co., of New York, proposes to add a deliquescent inorganic salt such as ammonium nitrate. Such a mixture might contain 50 per cent of nitrostarch, 40 per cent of the deliquescent ingredient and 10 per cent of water. (1,386,437; Aug. 2, 1921.)

Such a mixture may, however, be subject to some hydrolysis with subsequent decomposition and loss of stability. The presence of zinc oxide or hydroxide has been found effective in preventing this hydrolysis and Snelling in a second patent (1,386,438) adds 1 per cent to 5 per cent of such a zinc compound to the explosive mixture.

Another patent by the same inventor relates to the manufacture of nitrostarch explosives without recourse to the usual drying operations. The wet nitrostarch containing as much as 25 per cent of water is treated with a concentrated solution of ammonium nitrate and then centrifuged. In this way it is possible to substitute the ammonium nitrate solution for the water in the nitrostarch. Mixing this product with equal weight of dry ammonium nitrate one obtains a mixture which contains 37.5 per cent of nitrostarch, 56.25 per cent of ammonium nitrate and 6.25 per cent of water. This mixture is sensitive to commercial detonators and forms a highly desirable explosive (1,386,439; Aug. 2, 1921.)

Manufacture of Alum Cake.—Dr. Richard Moldenke, of Watchung, N. J., has recently been granted a patent for an improved method of producing alum cake—i.e., the commercial hydrated aluminum sulphate. It is claimed that the process yields a relatively pure product, free or nearly free from iron, and without an excessive loss of acid. Bauxite, clay or any other mineral containing alumina is finely ground and then mixed with sufficient strong sulphuric acid to form a paste or slurry. This paste is vigorously agitated at a high temperature (500 to 600 deg. F.) in an atmosphere of acid vapor in order to form aluminum sulphate and to prevent hardening into a cake or mass. After the reaction is completed the finely grained product is mixed with the amount of water necessary to make the crystallized aluminum sulphate. Under these conditions, a hot liquid mixture is obtained which can be readily separated from accompanying undissolved sand, clay, iron oxide, silica, etc., by simple filtration or settling. After removal of these insoluble residues, the clear liquid on cooling sets to a hard, crystalline, commercial cake. With care in the operation, this cake is practically free from iron. (1,388,436; Aug. 23, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Organic Chemical Manufacturers Form Association

Manufacturers of organic chemicals on Oct. 29 perfected a trade association after intensive consideration of the subject during two days' meetings in Washington. Dr. Charles H. Herty has resigned as editor of the *Journal of Industrial and Engineering Chemistry* to accept the presidency of the new organization, which is to be known as the Synthetic Organic Chemical Manufacturers' Association of the United States. The purposes of the organization, as set forth in the constitution, are:

> To advance the science of organic chemistry by encouraging the manufacture in the United States of all kinds of organic chemicals; to co-operate with the various agencies of the Government of the United States in its efforts to develop, improve and render serviceable a complete organic chemical industry; to promote cordial relations between American concerns and individuals engaged in the production and use of organic chemicals; to afford means for the dissemination of scientific knowledge; to promote the highest scientific and business standards in relation to the industry; and generally to take such collective action as may be proper for the establishment and perpetuation of the organic chemical independence of the United States of America.

The determination to secure Dr. Herty for the presidency of the association was reached late Friday night. Dr. Herty was at the Cosmos Club and had retired when the presence of a committee of manufacturers to wait upon him was announced. He rose to receive the committee and at first was determined not to accept the position offered him. The reasons that actuated him to change his mind are set forth in the following formal statement issued by Dr. Herty:

> At last there has been brought together one effective organization of men who, for the past five years, have been developing in this country all lines of manufacture of synthetic organic chemicals. The fine spirit shown throughout the meetings gave assurance of a strong organization which will aid in developing to its maximum efficiency this industry born of the war period and now recognized by all as being of such fundamental importance to the nation. Much progress has been made, but there is a long road ahead before we can hope to give to our country an industry which can worthily meet its every need. Toward that goal we are facing.
>
> The association as organized is thoroughly democratic in character. It follows national lines in this respect, for in the councils of the association the small manufacturer has equal voice with the larger and we all recognize that the success of the industry is closely bound up in the welfare of the small manufacturer. There have been some points of friction in the past between producer and consumer, but I believe that the hearty spirit of co-operation is developed which in the end will assure the future of this industry.
>
> Personally it seems strange to me to be leaving the ranks of the chemists for those of the manufacturers. For six years I have editorially striven to arouse first the chemist and then our people in general to the importance of developing this industry. The idea is now so clear to all that I feel my best efforts can be given to work with the manufacturers on their many problems in the hope of aiding them in the firm establishment of that industry which is so vitally important to this nation that Secretary Hoover, while emphasizing that the main consideration now was the development of this industry for utilization of waste, nevertheless added:
>
> "In these days of the development of forms of warfare that we have to exist under, it is fundamental and vital to us that we should maintain those industries on which we are bound to depend for our very vital existence if we ever come to conflict."

It was stated that the association is in no way a rejuvenation of the Dyes Institute and is not absorbing that organization. The new association is divided into four sections: Dyestuffs, Pharmaceuticals, Intermediates and Fine Organic Chemicals. Each section will have a vice-president, a secretary and an executive committee.

A board of governors, consisting of the president, the four vice-presidents and ten members to be nominated by the sections, will be the administrating body of the association. C. N. Turner was selected to be the Dyestuffs vice-president; Herman Seydell, the Pharmaceutical vice-president; S. W. Wilder, the Intermediate vice-president and B. T. Bush, the Fine Organic vice-president. Six other members of the board of governors were chosen as follows: R. S. Burdick, R. C. Jeffcott, August Merz, M. R. Poucher, P. Schleussner and F. P. Summers. The remaining four members, one from each section, will be chosen later.

Dean Cooley Discusses the Problems Facing the F.A.E.S.

During his first visit to the headquarters of the Federated American Engineering Societies since his election to the presidency of the organization, Dean Cooley announced his conclusion that the most necessary thing to do first is to tune up the existing machine so that it may be in the best working order to accomplish the multiplicity of tasks that are before it. Engineers are foremost, he says, in the actual service rendered the public, but the amount of public service they are capable of rendering can be increased immensely if the Federation can co-ordinate and direct the vast energies of the nation's engineers. The public already has been sold the idea of the Federation, Dean Cooley believes, but he thinks much education and hard work will be required before the Federation can be sold to the engineers themselves.

There is scarcely a limit to what engineers can do if they will really work to a common end, says Dean Cooley. Even if they were to limit themselves to efforts to stabilize industries and to eliminate waste, they could perform a national service of first magnitude and indirectly benefit themselves immeasurably, he believes. Only a little progress along these lines would have to be made before unemployment among engineers would disappear, in his estimation.

Dean Cooley points out that it is well understood why engineers, as a whole, have so few collective accomplishments to which they can point. It goes back to the schools, he says, where there is failure to give the engineer a well-rounded education. As a result, he stays within the narrow boundaries of his specialty. With the example of the spirit and point of view of such engineers as Herbert Hoover, Dean Cooley believes there is going to be a general breaking away from the meshes of technicality and that engineers are going to utilize the ability they already possess as economists and business men and become men of affairs.

Priestley Portrait Presented to National Museum

A copy of the Stewart portrait of Joseph Priestley was presented to the National Museum in Washington on Oct. 25 by Dr. Edgar F. Smith on behalf of the American Chemical Society. In making the presentation Dr. Smith told how Priestley, with the help of Washington and Jefferson, did much to stimulate the establishment of chemical industries in this country.

Disposal of British Government Surplus Chemicals

It is reported from London that the Disposal and Liquidation Commission has entered into a contract with Charles Tennant & Co., Glasgow, for the disposal of unsold chemicals and explosives on a commission basis.

More Plants Resuming Operations

Glassware. The American Window Glass Co., Monongahela, Pa., has resumed operations at its local plant after a shut-down for nearly a year. It is said that orders on hand insure continuous production for an indefinite period.

The Thatcher Mfg. Co., Kane, Pa., manufacturer of milk bottles, is increasing the working force at its local plant.

The DuBois Glass Co., Falls Creek, near DuBois, Pa., manufacturer of glass bottles, is making a number of improvements in its plant, including the installation of new equipment, and is said to be planning for a resumption of production at an early date. The works have been closed for many months.

Ceramic. General ware potteries in the eastern Ohio district have increased production to a point of about 75 per cent of normal, the most active schedule attained during the present year. A number of plants are operating at normal.

The National Fireproofing Co. has resumed production at its plant at Keasbey, N. J., for the manufacture of firebrick, following a shut-down for about eight months past. The plant has been equipped for electric operation and steam power will be abandoned. It is expected that a full working force will be employed at an early date.

The Jackson China Co., Falls Creek, near DuBois, Pa., has resumed operations at its pottery after being closed down since early in the year.

Chemical. The Keeler Chemical Co., Wetmore, Pa., manufacturer of methanol, acetate of lime, etc., is planning for the resumption of production at its plant early in November, after being idle since the first of the year.

Coke. The Mount Pleasant Coke Co., Carpentertown, Pa., has fired 310 coke ovens at its plant, following a shut-down since early in the year.

Steel. The Cumberland Steel Co., Cumberland, Md., has resumed full time production at its local plant, with curtailed working force, following a half-time operating schedule dating from last February.

The Parkersburg Iron & Steel Co., Parkersburg, W. Va., has resumed operations at its local mills after an idleness of a number of months. About 500 men will be employed.

The Alan Wood Iron & Steel Co., Conshohocken, Pa., has resumed operations at its open-hearth department, following a shut-down for a considerable period. Three furnaces at the Ivy Rock plant have been placed in service.

Paper. The Hinde & Dauch Paper Co., Muncie, Ind., has resumed production at its local mill with about sixty operatives, or approximately one-fourth of the regular working force. It is planned to increase the number of employees gradually. The mill has been closed for a number of months.

Miscellaneous. The Viscoloid Co., Leominster, Mass., manufacturer of celluloid products, has adopted a night operating schedule in certain departments of its plant.

The Yaryan Rosin & Turpentine Co., Brunswick, Ga., has resumed full time operations after an extensive curtailment dating from last February.

William M. Burton Chosen as Perkin Medalist

At a meeting of the Perkin Medal Committee of the Society of Chemical Industry, held at the Chemists' Club, Oct. 24, William M. Burton, president of the Standard Oil Co. of Indiana, was awarded the medal for 1921-1922. The formal presentation will be made Jan. 13, 1922.

Mr. Burton's work in the field of pyrolytic distillation of petroleum has brought him international fame. There are now in use in the United States about 2,000 stills in which his patented process is employed, producing in the neighborhood of 1,000,000,000 gal. of gasoline per year, in addition to the gasoline produced normally from crude oil. This amount represents from 20 to 25 per cent of the total gasoline produced in the United States.

Mr. Burton also observed that as a byproduct of the process there was produced an artificial asphalt which was practically identical with Trinidad asphalt from a chemical standpoint and also for practical use. Such asphalt is now widely used for road building, roofing and paving purposes.

The Business Publishers and Editors Meet in Chicago

The National Conference of Business Paper Editors and the Associated Business Papers, Inc., met in annual convention at Chicago on Oct. 24, 25 and 26. The central theme of the convention was the revival of business and what business papers can do to speed it along. The keynote speech for the publishers' convention was given by Mr. James H. McGraw, president of the McGraw-Hill Co., who pointed out that the task of interpreting the world's condition to American business must be assumed by business paper editors and publishers. The outstanding feature of the editors' session was a discussion of the relation between the Department of Commerce and the business papers by F. M. Feiker, assistant to Secretary Hoover. Mr. Hoover had himself hoped to be present to address the conference, but found it impossible to do so. The following telegram was received from him as evidence of his confidence in the business press and the importance of the work of the National Conference of Business Paper Editors:

> Pressure of official duties makes it impossible for me to address the members of the National Editorial Conference in Chicago, as I should like to do. I have appreciated the opportunity given me in the monthly meetings we have held together in Washington to express the policies of the Department of Commerce with regard to some of the pressing industrial questions before us. We have indeed great problems yet to solve. I cannot but feel that if these problems are considered as human and not as material questions, we can find their solution. We are dealing with questions of railways, of farms, of shops and of instruments of commerce and industry, but in the background of every person's mind there is the fact that we are dealing not with mechanical things but that we are concerned with the problems of men, women and children. There must be in our discussions of these matters the dominating thought that the better control of economic forces is in fact simply the better comfort of the country. Those several organizations within the Department of Commerce which we have developed and set at work within the past few months are concerned in this spirit, and it is a fine augury of our industrial future to know that the programs and purposes of these various departmental activities have come from our manufacturers, merchants and engineers themselves. The editors of the business press have shown a fine spirit of service. Your opportunity for leadership is unique and unchallenged. Upon you rests in large measure the responsibility of the control of industrial thought and opinion in the detail of the industrial, economic and technical problems which confront us. I wish your conference every success in carrying forward your high and constructive purposes.

The editors presented a résumé of conditions in the following basic industries: Iron and steel, railroads, marine, automotive, textiles, electrical, construction industries, mining, leather and agriculture. In general they indicated a slight improvement in business and an optimistic outlook. All felt that the bottom had been reached and that business is on the upward trend. No more hopeful picture of any industry was painted than of agriculture, which is generally supposed to be in the dumps.

At the election of officers James H. McGraw was chosen president of the Associated Business Papers. The editors elected the following group: C. J. Stark, *Iron Trade Review*, president; H. C. Parmelee, CHEMICAL & METALLURGICAL ENGINEERING, vice-president; W. W. Macon, *Iron Age*, secretary and treasurer. The following comprise the executive committee: A. I. Findley, *Iron Age;* V. E. Carroll, *Textile World;* S. O. Dunn, *Railway Age;* Harry Hilman, *Inland Printer;* James H. Stone, *Shoe Retailer*, and C. A. Moffat, *Druggists' Weekly.*

Leather Manufacturers Vote Against Cod Oil Tax

The board of directors, New England Shoe and Leather Association, Boston, Mass., has adopted resolutions protesting against the imposition of a tax on Newfoundland cod oil. It is held that this is essentially a raw material, requires no protection and that any tax will raise unnecessarily the cost of leather and leather products.

Meeting of Chicago Section A.C.S.

Friday, Oct. 21, was the occasion of the second monthly meeting of the Chicago Section of the American Chemical Society. With the increased interest in so many industries in hydrogen-ion concentration it was particularly timely that Dr. Paul E. Klopsteg of the Central Scientific Co. should speak at this meeting on the practical aspects of electrometric methods in chemistry. As a physicist of note, his work in co-operation with Dr. Wendt in the development of apparatus has been of distinct service not only to the research laboratory, but of still more importance to many scientifically controlled industrial operations.

Following the paper by Dr. Klopsteg, Dr. Wendt led a brief discussion on the method of operating the apparatus exhibited. Dr. Hale of Michigan, speaking for the Chemical Foundation, made some rather startling revelations concerning the extent of German competition in the dye manufacturing and consuming industries. Dr. H. E. Howe, who was a visitor, spoke briefly on the aims of the National Research Council.

The group meetings following the main address were enthusiastically carried forward on the following subjects:

Groups 1 and 2 (Laboratory Methods). Subject: The Electrolysis of Lead Tartrate Solutions. Leader: V. H. Gottschalk, of the Western Electric Co.; Subject: Determination of Free Alkali in Soap. Leader: M. L. Sheely, of the Armour Soap Works.

Group 3 (Synthesis). Subject: Synthesis of an Organic Arsenic Compound. Leader: H. C. Cheetham, of Northwestern University.

Group 4 (Biologic). Subject: Animal Biologic Derivatives. Leader: David Klein, of the Wilson Laboratories.

Hearings on River and Harbor Pollution Legislation

Drastic legislation in an effort to prevent pollution of waters in rivers and harbors probably will be recommended to the House of Representatives in the near future. This may be judged from the attitude of members of the House Committee on Rivers and Harbors during the course of the hearing on bills intended to prevent pollution of waters. John I. Tierney, representing the Manufacturing Chemists' Association, appeared before the committee and urged that before a step was taken which would interfere greatly with a large number of manufacturing plants the Secretary of Commerce be requested to conduct a scientific investigation as to the causes of water pollution. He told the committee that the discharges from chemical plants had very little effect on animal and vegetable life. He thought chemical manufacturing plants are being blamed in some cases for damage done by acid waters from coal mines.

While witnesses for the bill were able to show actual and material damage caused by the indiscriminate discharge of petroleum sludge from tank-ships, they were admittedly without specific data as to the damage done by the discharges of waste materials into streams from manufacturing plants. Mr. Tierney called the attention of the committee to the fact that the witnesses had presented no actual data showing that chemical waste had caused damage. He declared that Congress owes it to the industry not to interfere with the operation of its plants until properly qualified engineers should have made a study of the problem.

The committee may attempt to give some protection to manufacturing plants in the bill it will report, but apparently it is bent upon pressing legislation at this time which will affect materially the interests of all industries which discharge waste into streams.

French Imports of German Potash Cause Concern

Prominent men in the French potash industry express much concern over the large importations of potash from Germany. Despite the duty of 30 fr. per ton on chloride of potassium, German salts can be sold cheaper than the French product. The matter has been reported to the government.

Measurement of Color in Industry

At the regular monthly meeting of the Delaware Section of the American Chemical Society, held in Wilmington on Wednesday evening, Oct. 19, Dr. A. H. Pfund of Johns Hopkins University spoke on "Measurement of Color as Applied to Industrial Needs." The speaker's first work along this line was on lithopone paints. Practically all the so-called white paints have an outstanding tint, and by means of multiple reflection he has been able to accentuate this tint and to measure it.

In ordinary colorimetry and photometry the sensibility cannot be greater than that of the unaided human eye, and it has been found that the average physiological sensibility is only about 2 per cent. This, of course, is not accurate enough for quantitative work. The speaker pointed out that any color can be expressed absolutely by the three factors: brightness (or reflection coefficient), saturation and dominant hue. The first two are ratios or percentages, and the third is a definite wave-length. In order to express colors in this manner there must be marked improvement in the sensibility of the colorimeter.

Working along this line, Dr. Pfund has been successful in developing a differential tintometer. So far he has studied more particularly the comparison of two dyed skeins in order to check the dye-tester's judgment. The two samples are mounted at the ends of a track upon which slides a small nitrogen-filled electric bulb. Light from the two samples is reflected through a colorimeter tube to an eye-piece. The light source is moved along the track until the brightness of the two halves of the colorimeter field appears the same. By twisting one sample and thus increasing the reflection from it, the saturation or "strength" of the two samples is equalized. Then the two samples are interchanged. If they really are the same, the field will not be affected, but if they are not the same, there will be a marked difference. This device doubles the sensibility of the human eye.

In order to compare the dominant hues of the two samples, advantage is taken of the fact that the human eye is most sensitive to a certain hue in the purple. Color screens are introduced into the eye-piece so that, regardless of the actual hue of the sample, the light reaching the eye is purple. Here again the sensibility is doubled by interchanging the two samples. The color screens consist of an exceptionally ingenious arrangement of wedges, by which any desired wave-length can be transmitted or absorbed. The great sensibility of this differential tintometer was shown by a demonstration in which skeins that had been judged "O. K." by an expert dye-tester appeared to be markedly different when compared in the instrument.

Confer on Muscle Shoals

Following a conference on Muscle Shoals in Washington Oct. 24 among the Secretary of War, the Secretary of Commerce, Brigadier General Harry Taylor, W. B. Mayo and Colonel J. W. Worthington, Secretary Weeks declared that definite progress is being made and that the spread between the estimates of the Army engineers and the Ford engineers on the cost of the completion of the Wilson dam and the construction of dam No. 3 has been narrowed materially. Secretary Weeks stated that no bargaining was attempted at this conference, as that would be done between Mr. Ford and himself shortly after he has looked over the project personally, but his attitude indicated plainly that he is much more favorably impressed with the proposition in its present form than at any previous time.

Secretary Weeks left Washington Oct. 25 on his Southern trip and his plans included a personal inspection of the Wilson dam and the nitrate plants. Shortly after his return to Washington he expects to "get down to figures" with Mr. Ford.

German Company to Resume Manufacture of Fertilizers

The Badische Anilin und Sodafabrik announces that it will resume the manufacture of nitrogenous fertilizers in about three months.

Personal

Dr. V. L. BOHNSON has been promoted to an assistant professorship in general chemistry at the University of Wisconsin, Madison, Wis.

CHARLES FRÉMONT, who was awarded the Bessemer Gold Medal of the British Iron and Steel Institute, began to contribute to French technical literature in 1890. He is best known abroad through his researches in metallurgy and the strength of metals, especially iron and steel, and the apparatus invented by him for testing steel by shock. Besides the Bessemer Medal, he has also been awarded (in 1920) the great gold medal bearing Prony's effigy, by the French Société d'Encouragement pour l'Industrie Nationale, two great gold medals by the Société des Ingenieurs Civils de France (in 1897 and 1898), and over thirty prizes by the French Academie des Sciences and the Société d'Encouragement. M. Frémont is ingenieur-constructeur, chief of the mechanical laboratory of the French Ecole Nationale Supérieure des Mines, member of the Commission des Méthodes d'Essai des Materiaux de Construction in the French Ministry of Public Works, etc.

FEDERICO GIOLITTI arrived in the United States on Oct. 20.

Dr. WILLIAM J. HALE of the Dow Chemical Co. spoke before the Mining Congress on "Protecting American Industry."

WHITNEY S. HAMNETT, who was for twelve years with the Pittsburgh Testing Laboratory, eight of which were as manager of the Dallas (Tex.) branch and the last two as Eastern manager of the company at New York, has resigned, and has become associated with J. E. Dockendorff & Co., New York, American agent for two manufacturers of aluminum in Switzerland.

Dr. H. B. HART has been appointed research chemist for the Eagle-Picher Lead Co., Joplin, Mo.

W. LEE LEWIS, director of chemistry of Northwestern University, addressed the Chicago Chemists Club on Oct. 25 on "Joaquin Miller, the Poet of the Sierras."

E. P. MATHEWSON has gone to Burma, via Continental Europe. He expects to remain several months in the Far East studying metallurgical practice at the mill and smelter of the Burma Corporation.

W. R. OGLESBY, formerly with E. I. du Pont de Nemours & Co., is now vice-president of the American Food Products Corporation, New York City.

H. C. PARMELEE was a guest at the Chicago Chemists Club last week.

EDGAR F. SMITH addressed the American Mining Congress banquet in Chicago on Oct. 21.

C. E. WATTS, Steelton, Pa., chemist of the coke-oven department at the local plant of the Bethlehem Steel Co., was tendered a farewell dinner on Oct. 13 at Folger's Inn, Dauphin, Pa., by executives and associates at the works, on the occasion of his departure to West Virginia to take up work at the Bethlehem company's mines in that district.

The National Conference of Business Paper Editors, which recently met at Chicago, elected the following officers for the ensuing year: C. J. Stark, *Iron Trade Review*, president; H. C. Parmelee, CHEMICAL & METTALLURGICAL ENGINEERING, vice-president; W. W. Macon, *Iron Age*, secretary-treasurer. The following comprise the executive committee: A. I. Findley, *Iron Age*; V. E. Carroll, *Textile World*; S. O. Dunn, *Railway Age*; Harry Hilman, *Inland Printer*; James H. Stone, *Shoe Retailer*, and C. A. Moffat, *Druggists' Weekly*.

The executive committee of the National Safety Council elected the following vice-presidents for the National Safety Council: David S. Beyer, Liberty Mutual Insurance Co., Boston, vice-president for service to members; B. F. Tillson, New Jersey Zinc Co., Franklin, N. J., vice-president for industrial safety; F. A. Davidson, Dwight P. Robinson Co., New York City, vice-president for sectional activities; C. B. Scott, Bureau of Safety, Chicago, vice-president for local councils; David Van Schaack, Aetna Life Insurance Co., Hartford, Conn., vice-president for public safety; W. E. Worth, Chicago Safety Council, secretary and treasurer. W. H. Cameron, formerly secretary-treasurer of the National Workmen's Compensation Service Bureau, New York City, was elected executive secretary of the National Safety Council. Sidney J. Williams was re-elected chief engineer of the Council. C. W. Price, formerly general manager, will assist the National Safety Council as a special consultant in public safety. The executive committee approved the organization of a Drop Forge Section and a Petroleum Section by the companies in its membership interested in more intensive accident prevention activities in those two groups of industries.

Obituary

JESSE PETERSON, seventy-one years old, a fiber products manufacturer, died in Lockport, N. Y., on Oct. 22 of heart disease. Mr. Peterson was one of the first fiber manufacturers in America and organized the United Industrial Fiber Company in 1889.

CHARLES W. WHITLEY, vice-president of the American Smelting & Refining Co., New York, and in charge of the company's plants in the United States, died on Oct. 9.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Oct. 31, 1921.

The chemical industry during the past week was quite active and buying orders reached the market in good volume. On some commodities producers had to withdraw and wait for revised prices. Some of the largest alkali plants have gradually reduced their overhead and are reported working at capacity. The Solvay process plant of the Allied Chemical & Dye Corporation reported a rapid rise in demand for its products and this has caused production in all the company's departments to approach normal levels. Other leading plants have increased working capacity and it seems probable that the turn of the year will find the chemical industry on a stronger footing than at any time since the recent depression. Consumers have come into the market with greater interest and frequently desired to increase standing contracts.

The threatened railroad strike has at last been averted. It cannot be truthfully said that this unsettled condition has been the cause of a revival of active trading, but it has helped the market along to some extent, as consumers feared being left with empty shelves and those who had been accustomed to the hand-to-mouth method of buying were eager to buy well in advance. Market prices have reflected the marked increase of buying operations and in some instances the spot market was held at a war-time premium. Forward shipment business has also shown an increased interest.

The export trade is showing signs of improvement. Importations of English and German chemicals have not had a tendency to weaken standing quotations. Imported bleaching powder and prussiate of soda attracted considerable attention. Increased sales and inquiries were noted on sal ammoniac and cyanide of soda and prices were advanced accordingly. A better demand was also recorded on sulphuric and oxalic acids.

CHEMICALS

Dealers were offering spot *acetate of soda* at 4c. per lb., but might shade prices a trifle on firm round lot business. Leading manufacturers were asking up to 4¼c. for prime goods and quoted lesser quantities at 4¼c. per lb. The

demand for this product has not been very active and business has passed for small lots only. Sales of spot *bichromate of soda* were reported at 8@8¼c. per lb. It is possible that an odd lot might be picked up at 7¾c., but the greater portion of dealers were above this figure. Offerings around the trade were not heavy and the tone of the market appeared very firm at the close Solid *caustic soda* is attracting considerable attention at $4.10 per 100 lb., and large dealers were not inclined to quote below this figure at any time during the week. Quotations were generally heard at $4.10@$4.15 per 100 lb. for standard brand goods. Spot *caustic potash* has continued quite active all week, with sales reported up to 6c. per lb. for the imported 88-92 per cent. Large dealers are asking 6@6¼c. for this product and it is very doubtful if shipment material can be placed below 6c. in any direction. Offerings on spot were not heavy, as most of the imported shipments have been practically sold upon arrival. The firm tendency that has been so prevalent in the *prussiate of soda* market has not let up and sales have been made at 14¼@14¾c. per lb., with some sellers asking the outside figure in the late trading. Spot material is very scarce and the tone all around seems to be for higher prices.

Shipments are quoted firm at 14¼@14½c. per lb. Consumers are purchasing light *soda ash* in single bags at $2.10@$2.15 per 100 lb. Sales of barrels are reported at $2.45@$2.50 per 100 lb. Offerings were not heavy and numerous orders were booked for less than carload lots. Prices on *camphor* have been advanced by American refiners and the market closed in a very firm condition with buyers showing an increased interest. At the close prices were heard at 85@90c. per lb. Prices on *carbonate of copper* are quoted higher in some first-hand quarters, where sales are reported at 22c. per lb. In other directions a shade under this price can be done, but the tone of the market is decidedly stronger. Spot *formaldehyde* has been offered in the open market down to 11c. per lb. by second hands. The general range is from 11@12c. per lb. depending upon the quantity and seller. This product has not met with any active interest and first-hand competition has become keener for the small passing business. Prices on *oxalic acid* became somewhat firmer during the latter part of the week after a period of severe competition which brought the market down to 13c. per lb., the lowest figure recorded in the past few years. This price was still named by manufacturers at the close f.o.b. works, but spot material was quoted at 15c per lb. Buyers were very cautious in buying quantities owing to the unsettled conditions for this product. Manufacturers of domestic *sulphide of soda* are meeting competition with the imported material and offer the 60-62 per cent, fused, at 4¾c. per lb. in carload quantities. The broken variety is quoted at 5c. per lb. in round lots and 5¼c. in smaller portions. Crystals continue scarce, with 3¼c. per lb. quoted for domestic material.

Coal-Tar Products

There has been a substantial improvement noted in the entire list of coal-tar products during the past week and leading producers reported a more active demand than at any time this year. Consumers in many cases are requesting that some of their forward shipments be anticipated. Intermediate producers are more cheerful and feel that after a long depression of the most severe nature business is finally beginning in earnest. There were reports that orders were received from sources that were entirely out of the buying market for the past year. The active movement brought out the fact that spot material in resale hands is extremely low and that most of these products have been lying around for some time and are of an inferior quality. Prices in general have not changed to any marked extent and are not closely adhered to on firm business. The dyestuff field has witnessed the greatest gain in the coal-tar products industry, as the textile business has recovered much of its lost ground. Business was particularly good in dimethylaniline, para phenylenediamine and phenol. Some resale *benzene* sold at 38@40c. per gal., but consumers found it extremely difficult to obtain any round quantities at this level. Refiners are turning down all offers for immediate business and are quoting only future shipments.

The St. Louis Market

St. Louis, Mo., Oct. 27, 1921.

Trading in the chemical and drug markets for some time past has shown a consistent gain and during the past week a tremendous increase has been noticed, but it is the general opinion that the major part of this increase is only artificial, due to the present railroad situation. However, it is apparent that buyers are anticipating their requirements for a longer period than heretofore but nevertheless proceeding cautiously. The general trend of the market is very firm and weak holders are practically eliminated. The market as a whole is assuming a more normal and firmer position.

The market on *caustic soda* has not changed and is still moving normally at the prevailing price of $4 per 100 lb., basis 73 to 75 per cent solid, f.o.b. point of production. The *soda ash* market remains slow with price unchanged from last week. *Bicarbonate* and *sal soda* have not changed.

Acetphenetidin is commanding a better position since most of the second-hand lots on the market have been cleared away. *Ammonia water*, 26 deg., is one of the stable articles and moves through regular channels throughout the year. The heavy demand for *ammonium sulphate, pure granular*, which was reported in our last letter continues at the present time. *Bismuth salts* continue to move in an unusually large quantity and are in greater demand. *Bromides* are showing some increase. *Caffeine* is on the road to recovery in spite of the fact that competition is still very keen. *Carbon bisulphide* is moving in a large way. *Ether* is increasing in inquiries and demand. *Glycerine* is in good demand at 14c., in 500-lb. drums. The *copperas* market continues along routine lines with no change in price. *Glycerophosphates* are on a better movement. A regular trade in *hypo* continues. Jobbers should bear in mind that the season for *creosotes* and *guaiacols* is approaching and should be prepared to meet the demand by carrying good stocks. The *iodides* are moving beyond manufacturers' expectations and orders of large volume are being placed. *Phenolphthalein* demand is above normal. *Saccharine* continues to move in a moderate way. *Salicylates* have improved considerably and, this being a seasonable article, buyers should not hesitate to order liberal quantities. Sales of fairly large proportions have been reported on *sodium benzoate*, although the season for this article is virtually over. *Strychnine salts* were reduced by manufacturers, *alkaloid* now being quoted at $1.45 for crystals and $1.35 for powdered and the *sulphate*, crystals and powdered, at $1.15.

Manufacturers of heavy mineral acids report a general increase in activities and are very optimistic regarding the future. *Citric acid* demand is normal. *Acid tartaric* and *cream of tartar* are rather slow. Factors report a good increase in inquiries and demand for *pyrogallic acid*.

Castor oil is in strong demand with a price of 12½c., showing an increase of ½c. over previous report. *Linseed oil* suffered a drop during the preceding days, going as low as 68c., basis raw oil ex-warehouse. The demand is for spot and in small quantities. *Turpentine* remains steady at 79c. in single barrels and 75c. in 5-bbl. lots ex-warehouse.

Lithopone remains firm at 6½c., in less than carlots, and 6c. in carlots, with market getting stronger. Shipments have been good during the last ten days owing to the attempt of users trying to provide against the pending labor trouble. The market on *floated barytes* has not changed, price $23 per ton. The demand for this item shows an increase due to the pending railroad strike.

The Iron and Steel Market

Pittsburgh, Oct. 28, 1921.

The United States Steel Corporation has taken the lead, promptly followed by independents, in reducing prices of standard section rails from $45 per gross ton for bessemer rails and $47 for open-hearth to $40 for either description. About 1,500,000 tons of rails had been contracted for by the steam railroads for 1921 delivery, and about 1,000,000 tons had been taken out, the prospect being that the balance would be carried over to 1922. A reduction was in order for one time or another, as the old prices were those of the Industrial Board schedule of March 21, 1919, and all other steel products are now much below that schedule.

In most finished steel lines a slight tapering off in demand

is noticed in the past week, but a distinct exception is tubular goods, which show improved demand as to both oil country goods and standard pipe. In most trade circles there is a disposition to account for the change, after a period of three months of rather steadily increasing demand, on the ground that buyers are waiting for lower cost steel in connection with prospective freight rate reductions, which would lower the cost of steel and presumably the price, at the same time reducing the freight on the steel, paid by the buyer. The difficulty in accepting this explanation is that buying of steel products has been described right along as being of the hand-to-mouth character, and as rate reductions are unlikely to occur before about Jan. 1, if even on that date, it is difficult to see how there could be much postponement of buying such as would otherwise be in process. Perhaps a more natural explanation would be that steel demand has now recovered from its extreme depression, due to the necessity of liquidating stocks, and is now in normal relation to the character and volume of business the country is transacting, while the usual year-end dullness in the steel market is beginning to show itself.

Steel Prices

There have been no really important changes in finished steel prices for several weeks. There has been a sort of backing and filling in various branches of the trade, which in the general average has indicated no decided change toward softness or firmness. Tubular goods prices were formally reduced by the lists of Sept. 16, and these prices are now being shaded somewhat. Wire products were advanced Sept. 12, while the advance is not holding in all cases. Sheets were advanced $5 a ton in September. The advance is holding in black and galvanized, but not in blue annealed. A second advance, $5 a ton, has been announced by the majority of independents, but it is not actually effective, and the tone of the market is perhaps not as good as if the advance had not been attempted. Bars in small lots seem to be a shade firmer, but not in large lots. Shapes are reported firmer and plates weaker.

With the steel market in this somewhat unstable condition, with possibilities of demand being somewhat less active in the next few weeks, with freight rate reductions in nearby prospect, and with the showing that at present prices and wage rates and an operation at one-third of capacity, the Steel Corporation in September had earnings of $15 a ton, against earnings averaging $10 a ton in 1912 and 1913 with an operation of 88 to 90 per cent, the balance of probability is plainly that steel prices will tend to sag in the next few weeks rather than advance.

Mill Operations

Production of steel ingots appears to be at a rate nearer 40 per cent than 35 per cent of capacity, against an average of about 32 per cent in September and a dip under 20 per cent at the middle of July. Operation at rail, plate, shape and bar mills are under a 35 per cent rate on the whole, while the lighter products show a better operation, tin mills going at about 50 per cent, sheet mills at 65 to 85 per cent and pipe mills at 50 to 80 per cent.

Pig Iron and Coke

Extreme dullness continues in the pig-iron markets and prices are not overly firm. It is improbable that prices can avoid yielding when coal, coke and limestone freight rates are reduced. The recent reduction in iron ore freight rates has not been reflected, as the furnaces had large piles of ore already and were anxious to liquidate, irrespective of the precise time of the freight rate reduction, which would affect fresh supplies. The market remains quotable, although now largely nominal, at $20 for bessemer, $19.25 to $20 for basic and $21 for foundry, f.o.b. valley furnaces.

Connellsville coke shows a slightly easier tone, prices remaining at approximately the cost of production. The balance is slightly against the coke operators, as they have been showing slightly more avidity in resuming operations than have the blast furnaces. The market is quotable as follows: Spot furnace, $3.25 to $3.50; contract furnace, $3.40 to $3.50; spot foundry, $4.25 to $4.75, per net ton at ovens.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.45
Acetone	lb.	$0.12½– $0.12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.75 – 3.00	3.25 – 3.50
Acetic, 56 per cent	100 lbs.	6.00 – 6.25	6.50 – 7.00
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	10.75 – 11.00	11.25 – 11.50
Boric, crystals	lb.	.12¼– .13	.13½– .14
Boric, powder	lb.	.13 – .13½	.14 – .14½
Citric	lb.	..... –	.45 – .47
Hydrochloric	100 lb.	1.25 – 1.50	1.60 – 1.75
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.12½– .13
Lactic, 44 per cent tech	lb.	.09½– .10	.10½– .12
Lactic, 22 per cent tech	lb.	.04½– .05½	.06 – .07
Molybdic, C.P.	lb.	3.25 – 3.50	3.60 – 4.00
Muriatic, 20 deg. (see hydrochloric)	....	..... –	..... – .....
Nitric, 40 deg	lb.	.06¼– .06½	.06½– .07
Nitric, 42 deg	lb.	.06¾– .07	.07¼– .07½
Oxalic, crystals	lb.	.14½– .14¾	.15 – .16
Phosphoric, 50 per cent solution	lb.	.13 – .13½	.14 – .18
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.75 – 1.90
Sulphuric, 60 deg., tank cars	ton	..... –	11.00 – 12.00
Sulphuric, 60 deg., drums	ton	..... –	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	..... – .....
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00 – 22.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00 – 23.50	24.00 – 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.75 – .85
Tannic (tech.)	lb.	.45 – .48	.50 – .55
Tartaric, imported crystals	lb.	..... –	.26 – .27
Tartaric acid, imported, powdered	lb.	..... –	.27½– .28½
Tartaric acid, domestic	lb.	..... –	..... – .35
Tungstic, per lb. of WO	lb.	..... –	1.10 – 1.20
Alcohol, Ethyl	gal.	..... –	4.70 – 5.00
Alcohol, Methyl (see methanol)	.....	..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.37 – .38
Alcohol, denatured, 190 proof	gal.	..... –	.35 – .36
Alum, ammonia, lump	lb.	.03½– .03¾	.04 – .04½
Alum, potash, lump	lb.	.03¼– .04	.04½– .04¾
Alum, chrome lump	lb.	.10 – .11	.11½– .12½
Aluminum sulphate, commercial	lb.	.01½– .02	.02½– .02¾
Aluminum sulphate, iron free	lb.	.02½– .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½– .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium chloride, granular (white salammoniac)	lb.	.07 – .07½	.07½– .07¾
Ammonium chloride, granular (gray salammoniac)	lb.	.07 – .07½	.07½– .07¾
Ammonium nitrate	lb.	.07½– .07¾	.07¾– .08¼
Amylacetate tech	gal.	..... –	2.40 – 2.70
Arsenic oxide, (white arsenic) powdered	lb.	.05½– .06	.06½– .06¾
Arsenic, sulphide, powdered (red arsenic)	lb.	.11 – .11½	.12 – .13
Barium chloride	ton	46.00 – 47.00	48.00 – 50.00
Barium dioxide (peroxide)	lb.	.20 – .21	.22 – .23
Barium nitrate	lb.	.07½– .08	.08½– .09
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½– .05
Bleaching powder (see calc. hypochlorite)	.....	..... –	..... – .....
Blue vitriol (see copper sulphate)	.....	..... –	..... – .....
Borax (see sodium borate)	.....	..... –	..... – .....
Brimstone (see sulphur, roll)	.....	..... –	..... – .....
Bromine	lb.	.27 – .28	.28½– .30
Calcium acetate	100 lbs.	2.00 – 2.05	..... – .....
Calcium carbide	lb.	.04½– .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	23.50 – 24.00	24.50 – 25.50
Calcium chloride, granulated	lb.	.01½– .02	.02½– .02¾
Calcium hypochloride (bleach'g powder)	100 lb.	2.35 – 2.40	2.50 – 3.25
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.85 – .90
Carbon bisulphide	lb.	.06½– .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.10½– .10¾	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)	.....	..... –	..... – .....
Caustic soda (see sodium hydroxide)	.....	..... –	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½– .10
Chloroform	lb.	..... –	.40 – .43
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas (see iron sulphate)	.....	..... –	..... – .....
Copper carbonate, green precipitate	lb.	.21 – .22	.22½– .23
Copper cyanide	lb.	..... –	.50 – .62
Copper sulphate, crystals	lb.	.05 – .05¼	.05½– .06
Cream of tartar (see potassium bitartrate)	.....	..... –	..... – .....
Epsom salt (see magnesium sulphate)	.....	..... –	..... – .....
Ethyl Acetate Com. 85%	gal.	..... –	1.00 – 1.10
Ethyl Acetate pure (acetic ether, 98% to 100%)	gal.	..... –	.95 – .....
Formaldehyde, 40 per cent	lb.	.11 – .11½	.11½– .12½
Fusel oil, ref	gal.	..... –	2.65 – 3.00
Fusel oil, crude	gal.	..... –	1.50 – 1.75
Glauber's salt (see sodium sulphate)	.....	..... –	..... – .....
Glycerine, C. P. drums extra	lb.	..... –	.14 – .15
Iodine, resublimed	lb.	..... –	3.50 – 3.60
Iron oxide, red	lb.	..... –	.10 – .20
Iron sulphate (copperas)	ton	18.00 – 19.00	20.00 – 23.00
Lead acetate	lb.	..... –	.10½– .12½
Lead arsenate, paste	lb.	.09 – .09½	.10 – .11
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½– .08	.08½– .09
Lithium carbonate	lb.	..... –	1.40 – 1.50
Magnesium carbonate, technical	lb.	.08 – .08½	.09 – .10
Magnesium sulphate, U. S. P.	100 lb.	2.50 – 2.75	..... – .....
Magnesium sulphate, technical	100 lb.	..... –	1.10 – 1.75
Methanol, 95%	gal.	..... –	.66 – .68
Methanol, 97%	gal.	..... –	.70 – .72
Nickel Salt, double	lb.	..... –	.12 – .12½
Nickel salt, single	lb.	..... –	.14 – .14½
Phosgene (see carbonyl chloride)	.....	..... –	..... – .....
Phosphorus, red	lb.	.40 – .41	.42 – .45
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.10½– .11	.11½– .11¾

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .. – $....	$0.25½–$0.28
Potassium bromide, granular	lb.	..... –	.14 – .20
Potassium carbonate, U. S. P.	lb.	.20 – .21	.22 – .25
P tassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
P tassium chlorate, crystals	lb.	.08 – .08¼	.08½ – .12
I otassium cyanide	lb.	..... –	.26 – .28
Potassium hydroxide (caustic p tash)	lb.	.06 – .06¼	.06½ – .08
Potassium iodide	lb.	..... –	2.60 – 2.75
Potassium nitrate	lb.	.07¾ – .07½	.08 – .09
Potassium permanganate	lb.	.18 – .19	.20 – .22
Potassium prussiate, red	lb.	.28 – .29	.29½ – .30
Potassium prussiate, yellow	lb.	.20 – .20½	.21 – .22
Rochelle salts (see sodium potas tartrate)	....	....	..... – .....
Salammoniac (see ammonium chloride)	...	....	..... – .....
Sal soda (see sodium carbonate)	...	..... –	..... – .....
Salt cake (bulk)	ton	..... –	20.00 –22.00
Silver cyanide	oz.	..... –	1.35 – 1.38
Silver nitrate	oz.	..... –	.46 – .47
Soda ash, light	100 lb.	2.10 – 2.15	2.20 – 2.60
Soda ash, dense	100 lb.	2.35 – 2.40	2.45 – 2.70
Sodium acetate	lb.	.04 – .04¼	.04½ – .05
Sodium bicarbonate	100 lb.	2.00 – 2.25	2.50 – 2.75
Sodium bichromate	lb.	.08 – .08¼	.08¼ – .08¾
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .05	.05½ – .06
Sodium borate (borax)	lb.	.05½ – .06	.06½ – .07
Sodium carbonate (sal soda)	100 lb.	1.75 – 1.90	2.00 – 2.25
Sodium chl rate	lb.	.07½ – .07¾	.08 – .08½
Sodium cyanide	lb.	.27 – .28	.28½ – .30
Sodium fluoride	lb.	.11 – .12	.12½ – .14
Sodium hydroxide (caustic soda)	100 lb.	4.10 – 4.15	4.20 – 4.75
Sodium hyposulphite	lb	..... –	.03½ – .03¾
Sodium nitrite	lb.	.06½ – .07	.07½ – .07½
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½ – .04½	.04½ – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.21 – .24
Sodium prussiate, yellow	lb.	.14½ – .14¾	.15 – .15½
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.15	1.25 – 1.40
Sodium silicate, solution (60 deg.)	lb.	.02½ – .02¾	.03 – .03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60-62 per cent (cone.)	lb.	.04½ – .05	.05¼ – .05½
Sodium sulphite, crystals	lb.	.03½ – .03¾	.04 – .04½
Strontium nitrate, powdered	lb.	.12 – .13	.13½ – .20
Sulphur chl ride, red	lb.	.05 – .05½	.05½ – .06¼
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	.19½ – .20
Tin oxide	lb.	..... –	.37 – .38½
Zinc carbonate, precipitate	lb.	.16 – .16½	.17 – .17
Zinc chloride, gran	lb.	.09½ – .09¾	.10 – .11
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11½ – .11¾	.11½ – .12½
Zinc oxide, XX	lb.	.07 – .07½	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.15 — $1.20
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.27 — .30
Aniline oil, drums extra	lb.	.17½ — .20
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.35 — 1.45
Benzidine, base	lb.	.90 — 1.00
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.31 — .34
Beta-naphthyla mine, sublimed	lb.	1.75 — 1.85
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 25-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.10 — 1.20
Dimethylaniline	lb.	.60 — .65
Dinitrobenzene	lb.	.23 — .27
Dinitroclorbenzene	lb.	.20 — .25
Dinitronaphthalene	lb.	.30 — .35
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, car lots, in drums	gal.	.30 — .35
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.05 — 1.15
Meta-phenylenediamine	lb.	1.15 — 1.20
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.65 — 1.70
Naphthalene crushed, in obls.	lb.	.06½ — .08½
Naphthalene, flake	lb.	.06¾ — .08½
Naphthalene, balls	lb.	.08 — .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	3.00 — 3.10
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.40 — 1.45
Para-amidophenol, HCl	lb.	1.70 — 1.80
Para-dichlorbenzene	lb.	.12 — .15
Paranitroaniline	lb.	.77 — .80
Para-nitrotoluene	lb.	.80 — .85
Para-phenylenediamine	lb.	1.70 — 1.75
Para-toluidine	lb.	1.25 — 1.40
Phthalic anhydride	lb.	.40 — .50
Phenol, U. S. P., drums	lb.	.09½ — .12
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.50 — 1.60
Resorcinol, pure	lb.	2.00 — 2.25
Salicylic acid, tech., in bbls.	lb.	.18 — .20
Salicylic acid, U. S. P.	lb.	.19 — .22
Salol	lb.	.60 — .70
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.27 — .30
Tolidine	lb.	1.30 — 1.35
Toluidine, mixed	lb.	.43 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.19 — $0.40
Beeswax, refined, dark	lb.	.24 — .25
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.36 — .42
Candellila wax	lb.	.24 — .25
Carnauba, No. 1	lb.	.46 — .47
Carnauba, No. 2, North Country	lb.	.24 — .24½
Carnauba, No. 3, North Country	lb.	.14½ — .15
Japan	lb.	.21 — .22
Montan, crude	lb.	.04½ — .05
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½ — .03½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02 — ....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ — .03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.03¾ — .04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ — .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ — .05½
Stearic acid, single pressed	lb.	.09¾ — ....
Stearic acid, double pressed	lb.	.10 — ....
Stearic acid, triple pressed	lb.	.11 — .11¼

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.45 —	5.50
Rosin E-I	280 lb.	5.55 —	5.75
Rosin K-N	280 lb.	6.10 —	6.75
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.82 —	.....
Wood turpentine, steam dist	gal.	.80 —	.....
Wood turpentine, dest. dist	gal.	.78 —	.....
Pine tar pitch, bbl	200 lb.	..... —	6.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl	500 lb.	—	10.00
Rosin oil, first run	gal.	.35 —	.....
Rosin oil, second run	gal.	.37 —	.....
Rosin oil, third run	gal.	.44 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote ref	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.37
70-72 deg., steel bbls. (85 lb.)	gal.	.35
68-70 deg., steel bbls. (85 lb.)	gal.	.34
V. M. and P. naphtha, steel bbls (85 lb.)	gal.	.23

Fertilizers

Ammonium sulphate, bulk and d. bags	100 lb.	$2.70 —	3.00
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Cyanamide, f.o.b. works	unit	4.50	
Fish scrap, dom., dried, f.o.b. works	unit	2.90 —	3.00
Nitrate soda	100 lb.	2.35 —	2.45
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c.	ton	4.50 —	6.50
Tennessee, 78-80 p.c.	ton	8.00 —	9.00
Potassium muriate, 80 p.c.	ton	37.50 —	40.00
Potassium sulphate	unit	1.15 —	1.20

Crude Rubber

Para—Upriver fine	lb.	$0.21 —	.21½
Upriver coarse	lb.	.11½ —	.12
Upriver caucho ball	lb.	.11 —	.12
Plantation—First latex crepe	lb.	.15½ —	.15½
Ribbed smoked sheets	lb.	.15½ —	.15½
Brown crepe, thin, clean	lb.	.15 —	.....
Amber crepe No. 1	lb.	.17 —	.....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13 —	.13½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.09½ —	.09¾
Cocoanut oil, Cochin grade, in bbls.	lb.	.10½ —	.10¾
Corn oil, crude, in bbls.	lb.	.10½ —	.10½
Cottonseed oil, crude (f. o. b. mill)	lb.	.07½ —	.07¾
Cottonseed oil, summer yellow	lb.	.09 —	.09¼
Cottonseed oil, wi ter yellow	lb.	.09½ —	.10

Linseed oil, raw, car lots (domestic)	gal.	.67 —	.68
Linseed oil, raw, tank cars (domestic)	gal.	.62 —	.63
Linseed oil, in 5-bbl lots (domestic)	gal.	.70 —	.71
Olive oil, Denatured	gal.	$1.15 —	$1.20
Palm, Lagos	lb.	.07 —	.07½
Palm, Niger	lb.	.06½ —	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08 —	.08½
Peanut oil, refined, in bbls	lb.	.11½ —	.11¾
Rapeseed oil, refined in bbls	gal.	.85 —	.87
Rapeseed oil, blown, in bbls	gal.	.92 —	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07½ —	....
FISH			
Light pressed menhaden	gal.	$0.40 —	....
Yellow bleached menhaden	gal.	.42 —	....
White bleached menhaden	gal.	.44 —	....
Blown menhaden	gal.	.48 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	20.00 —	24.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24.00
Barytes, crude, first grade, Missouri	net ton	7.00 —	....
Blanc fixe, dry	lb.	.04 —	.04½
Blanc fixe, pulp	net ton	45.00 —	55.00
Casein	lb.	.07 —	.10
Chalk, Precipitated, domestic, extra light	lb.	.04½ —	.05
Chalk, Precipitated, domestic, light	lb.	.04 —	.04½
Chalk, Precipitated, domestic, heavy	lb.	.03½ —	.04
Chalk, Precipitated, English, extra light	lb.	.04½ —	.05
Chalk, Precipitated, English, light	lb.	.04½ —	.05
Chalk, Precipitated, English, dense	lb.	.04 —	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50 —	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00 —	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	12.00 —	20.00
China clay (kaolin), imported, powdered	net ton	25.00 —	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00 —	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00 —	16.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.06 —	.07
Graphite, Ceylon chip	lb.	.04½ —	.05
Graphite, high grade amorphous crude	lb.	.02¾ —	.02¾
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00 —	....
Kieselguhr, f.o.b. N.Y.	per ton	61.00 —	....
Magnesite, calcined	per ton	66.00 —	70.00
Pumice stone, imported	lb.	.03 —	.40
Pumice stone, domestic, lump	lb.	.05 —	.05¼
Pumice stone, domestic, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.68 —	.70
Shellac, orange superfine	lb.	.80 —	.82
Shellac, A. C. garnet	lb.	.58 —	.60
Shellac, T. N.	lb.	.68 —	.70
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	12.50 —	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50 —	11.00
Talc, imported	ton	30.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton		$50.00
Carborundum refractory brick, 9-in.	less than carlot	1,000	1250.00
	carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton		52– 55
Chrome cement, 40–45% Cr_2O_3	net ton		30– 32
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton		33– 35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		35– 40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		30– 35
Magnesite brick, 9-in. straight	net ton		65– 70
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b Chicago district	1,000		40– 42
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000		42– 45
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000		35– 38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.11 —	....
Ferrochrome, per lb. of Cr. contained, 4–6% carbon, carlots	lb.	.11 —	12
Ferromanganese, 76–80% Mn, domestic	gross ton	60.00 —	63.00
Ferromanganese, 76–80% Mn, English & German	gross ton	59.00 —	60.00
Spiegeleisen, 18–22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50–60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10–15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	60.00 —	65.00
Ferrosilicon, 75%	gross ton	130.00 —	135.00
Ferrotungsten, 70–80%, per lb. of contained W	lb.	.40 —	.45
Ferrouranium, 35–50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30–40% per lb. of contained V.	lb.	4.25 —	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	24.00 —	26.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	24.00 —	26.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	12.00 —	13.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.20 —	.21
Manganese ore, chemical (MnO_2)	net ton	50.00 —	55.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.75 —	3.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.1

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	13.00
Aluminum, 98 to 99 per cent	24.50@25.00
Antimony, wholesale lots, Chinese and Japanese	5.00@5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	28.00
Lead, New York, spot	4.70@4.75
Lead, E. St. Louis, spot	4.45@4.50
Zinc, spot, New York	5.05@5.10
Zinc, spot, E. St. Louis	4.675

OTHER METALS

Silver (commercial)	oz.	$0.71½
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	82.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00–60.00
Mercury	75 lb.	38.00–39.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.50
Copper bottoms	28.00
Copper rods	19.00@19.75
High brass wire	15.75
High brass rods	13.25
Low brass wire	17.25
Low brass rods	17.25
Brazed brass tubing	25.00
Brazed bronze tubing	29.75
Seamless copper tubing	19.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.50@10.00	9.25	9.50
Copper, heavy and wire	9.00@9.25	8.50	8.50
Copper, light and bottoms	7.50@8.00	7.50	7.25
Lead, heavy	3.25@3.50	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.25@4.50	4.50	5.00
Brass, light	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings	4.00@4.25	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.88	$2.88	$2.88
Soft steel bars	2.78	2.78	2.78
Soft steel bar shapes	2.78	2.78	2.78
Soft steel bands	3.42	3.48	3.48
Plates, ¼ to 1 in. thick	2.88	2.88	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

TUSCALOOSA—Members of the industrial committee of the local Chamber of Commerce are perfecting plans for the establishment of a local paper mill, to specialize in the manufacture of bond, kraft and other papers.

California

SAN FRANCISCO—Technion, Inc., manufacturer of composition of tiling, wainscoting, etc., has established a new plant at 524 Gough St., and plans for extensive operations. Alexander R. Balm is president, and J. W. Rowell, vice-president and production manager.

Georgia

COLUMBUS—The Southern Cotton Oil, Ninth Ave., is said to be planning for the rebuilding of its plant, recently partly destroyed by fire.

Illinois

CHICAGO—The American Tar Products Co., 208 South La Salle St., has commenced the erection of its proposed new local plant, to be equipped for the production of tar and tar byproducts.

Louisiana

ABBEVILLE—The Peoples' Sugar Refinery, Rose Hill, near Abbeville, is planning for the rebuilding of its local sugar mill, destroyed by fire, Oct. 13, with loss estimated at about $300,000, including machinery.

Maryland

BALTIMORE—The Chesapeake Paper Board Co., Key Highway and Baltimore & Ohio R.R., will soon commence the enlargement of its plant to provide approximately double the present output, or about 100,000 lb. of material every 24 hours. The machinery installation is estimated to cost in excess of $50,000. An extension will be constructed to the power house. J. S. Smith is president.

BALTIMORE—The American Sugar Refining Co. has filed plans for the erection of another building at its new plant now in course of erection at Woodall and Clements Sts. It will be 1-story, 55 x 107 ft. Stone & Webster, Inc., 120 Broadway, New York, has the building contract.

BALTIMORE—The Patuxent Clay Products Co., 206 Water St., recently incorporated with a capital of $1,000,000, is having plans prepared for the erection of a new local plant to cost about $150,000, for the manufacture of hollow tile and other burned clay products. The company is headed by Herbert W. Holmes and Harry Hanna.

Massachusetts

LEOMINSTER—The Viscaloid Co., manufacturer of celluloid products, has awarded a contract to Wiley & Foss, Central St., Fitchburg, Mass., for the construction of a 3-story plant addition on Lancaster St., 40 x 50 ft. A. S. Paton is president.

SALEM—The Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, Pa., manufacturer of oil products, is planning for the erection of a new local plant on Jeffers Ave. New England headquarters are at 248 Boylston St.

Michigan

CADILLAC—R. J. Teetor, Muskegon, Mich., is completing plans for the erection of a new 1-story and basement foundry, 75 x 100 ft., at Cadillac. Frank D. Chase, Inc., 645 Michigan Ave., Chicago, Ill., is architect and engineer.

ANN ARBOR—The University of Michigan, S. W. Smith, secretary, University Hall Bldg., has preliminary plans under way for the erection of a new chemical laboratory at the institution, estimated to cost about $75,000.

Missouri

ST. LOUIS—The Republic Photographic Corp., Kansas City, Mo., has acquired property totaling about 6 acres at St. Louis, to be used as a site for the erection of a new plant for sensitized photographic paper manufacture. Preliminary plans are under way. E. B. Fish is president.

ST. LOUIS—The St. Louis Lead & Oil Works, International Life Bldg., will break ground at once for the erection of a new power house at its plant on Manchester St.

New Jersey

CAMDEN—Fire, Oct. 19, destroyed a portion of the plant of the Camden Copper Works, Second and Royden Sts., with loss estimated at about $11,000.

NEWARK—The Celluloid Co., 290 Ferry St., manufacturer of celluloid products, has awarded a contract to Enstice Bros., 40 Clinton St., for the erection of a new 1-story and basement building, 73 x 240 ft., at Westcott and Niagara Sts., estimated to cost about $200,000.

JERSEY CITY—Fire, Oct. 15, destroyed a portion of the plant of the C. A. Woolse Paint & Color Co., 500 Grand St. An official estimate of the loss has not been made.

TRENTON—Fire, Oct. 21, destroyed a portion of the plant of the Enterprise Rubber Co., Enterprise Ave., manufacturer of rubber products, with loss estimated at about $25,000. John McCue is head.

New York

NIAGARA FALLS—The American Motorists' Refining Co., has construction under way on a new oil refinery on a 30-acre tract of property recently acquired in the northern section of the city.

ROCHESTER—The Pennsylvania Glass Sand Co., Lewiston, Me., is reported to be planning for the immediate erection of a new local mill, to be equipped for grinding feldspar, etc., estimated to cost about $45,000, to be 1-story, 50 x 130 ft.

BUFFALO—The Standard Mirror Co., 155 Harrison St., has plans under way for the erection of a new 1-story building at its plant, 60 x 120 ft. Bids will be asked at once. Colson & Hudson, Dun Bldg., are architects.

North Carolina

SALISBURY—The American Foundry Co. is completing plans for the erection of a new 1-story foundry, 60 x 120 ft., for the production of iron and other metal castings. Thomas G. Shelton is manager.

MICAVILLE—The Carolina Feldspar Co., Box 1025, Asheville, N. C., is planning for extensive developments and operations at its properties in the vicinity of Micaville, to include the grinding and pulverizing spar and kindred products. F. Frazier Glenn is president and general manager, address noted.

BURLINGTON—The Chamber of Commerce is developing plans for the establishment of a new local plant for the manufacture of terra cotta specialties, drain tile and other burned clap products. J. V. Mann is secretary.

Ohio

BARBERTON—The receivers for the Portage Rubber Co. have offered the plant and property to F. A. Seiberling, former head of the Goodyear Tire & Rubber Co. and now president of the Lehigh Tire & Rubber Co., New Castle, Pa., for a consideration of $1,000,000, or $250,000 in excess of the amount Mr. Seiberling has tendered for the works. If the sale is consummated, the plant will be operated in conjunction with the New Castle works.

YOUNGSTOWN—The Paul J. Kalman Co., 22 West Munroe St., Chicago, Ill., manufacturer of steel products, is planning for the early erection of a new steel fabricating plant, 400 x 420 ft., at Youngstown, estimated to cost close to $200,000 with equipment.

Pennsylvania

KITTANING—The Templeton Limestone Co., with plant at Templeton, near Kittanning, has construction under way on the rebuilding of its crusher building and power house, 30 x 60 ft., and 25 x 25 ft., respectively, recently destroyed by fire. The work is estimated to cost about $50,000. W. L. Snyder is superintendent.

KANE—Fire, Oct. 18, destroyed a building of the Nansen Chemical Co., Nansen, near Kane, with loss estimated at about $25,000.

PHILADELPHIA — The Pennsylvania Sugar Co., North Penn St., has acquired the property at 1015-21 North Penn St., adjoining its works, from the J. W. Paxson Co., for a consideration said to be $145,000. The site is improved with a 3-story factory and other buildings, and will be used by the new owner in connection with its plant.

WILLIAMSPORT, PA.—C. A. Reed & Co., Willow and Laurel Sts., manufacturer of paper products, has awarded a contract to Charles W. Fell & Co., South and Willow Sts., for the erection of its proposed new 4-story plant, 70 x 100 ft., estimated to cost $100,000.

PHILADELPHIA — The Philadelphia Paper Mfg. Co., Mixon St., Manayunk, has filed plans for the erection of a new building at its plant 100 x 180 ft., estimated to cost about $30,000.

Tennessee

CHATTANOOGA—The Ocoee Copper Co., 1135 Volunteer Life Bldg., has plans under way for the erection of a new plant at Ducktown, near Chattanooga, estimated to cost about $200,000. J. I. Carter is president. L. R. Hope, Ducktown, is engineer.

MEMPHIS—G. N. Shepardson is considering plans for the rebuilding of his local potash manufacturing plant, recently damaged by fire with loss of about $23,000.

CHATTANOOGA—The Cities Brick Co., Curtain Pole Road, has preliminary plans under way for the erection of an addition to its plant.

Texas

BEAUMONT—The Magnolia Petroleum Co., Dallas, Tex., is planning for the rebuilding of the portion of its gasoline plant recently destroyed by fire with loss reported in excess of $300,000.

BRECKENRIDGE—The laboratory building and other structures at the plant of the Mystic Gasoline Co., were destroyed by fire, Oct. 4, with loss estimated at about $14,000.

West Virginia

BELLE—The Belle Alkali Co. has awarded a contract to the Korns-Thomas Contracting Co., First National Bank Bldg., Huntington, W. Va., for the erection of additions in its plant, including improvements and alterations in the present works, estimated to cost about $300,000. D. W. Stubblefield is manager.

SUTTON—The Sutton Chemical Co. has acquired a large tract of property, totaling about 5,000 acres in the vicinity of Wolf and Stoney Creeks, to be used for certain raw material supply for the local plant.

PRINCETON—The Princeton Brick Co. has plans under way for extensions and improvements in its plant. Additional machinery will be installed.

STAR CITY—The new plant of the Star Glass Co., 93 Washington St., Morgantown, W. Va., to be erected at Star City, will total about 75,000 sq.ft. of manufacturing area, and is estimated to cost about $200,000. Construction will be commenced at once. H. J. Wagoner is secretary and treasurer.

Capital Increases, Etc.

THE UNITED STATES TURPENTINE & ROSIN Co., Mobile, Ala., has filed notice of increase in capital from $3,000,000 to $6,000,000.

THE STANWOOD RUBBER Co., Newark Ave., Elizabeth, N. J., has been taken over by a reorganization committee and receivership, operative for about a year past, has been terminated. The new company proposes to issue bonds for $175,000 and stock for $651,000, and will operate the local plant. A consideration of $360,000 was given for the property.

THE MARTIN LEATHER Co., Fifth and Spruce Sts., Wilmington, Del., has filed notice of increase in capital from $700,000 to $1,500,000.

A stockholders' committee is perfecting plans for the reorganization of the BUTTERWORTH-JUDSON CORP., Doremus Ave., Newark, N. J., manufacturer of chemicals, dyes, etc. The committee is composed of Chellis A. Austin, chairman; William A. Bradford, and Thomas L. Chadbourne.

New Companies

THE IVA-LITE CORP., Boston, Mass., has been incorporated with a capital of $250,000, to manufacture glass products of various kinds. Robert T. Russell is president; and M. S. MacDonald, 175 Cypress St., Newton, Mass., treasurer.

NOEPEL & BLAIR, INC., Boonton, N. J., has been incorporated with a capital of $25,000, to manufacture leather products. The incorporators are Charles W. Blair, I. J. and Jacob E. Noepel, 65 Harrison St., Boonton.

THE GWYNEED CLAY PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with a capital of $125,000, to manufacture hollow tile, firebrick and other burned clay products. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

THE BORG CORPORATION, New York, N. Y., has been incorporated with a capital of $100,000, to manufacture shellac, glue and kindred products. The incorporators are F. C. Leubuscher, J. W. Suling and J. C. Skinner. The company is represented by Leubuscher & Suling, 258 Broadway, New York.

THE MOTOR CITY SOAP CO., Detroit, Mich., has been organized under state laws to manufacture soaps and affiliated products. The incorporators are James L. and F. Cowan, and Ira Snyder, 5715 Third Ave., Detroit.

THE CHICAGO DRUG & CHEMICAL MFG. CO., 2201 West Roosevelt Road, Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts, drugs, etc. The incorporators are David Rish, Max Karno and Benjamin Michelson.

THE HUDSON VALLEY PORTLAND CEMENT CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture cement. The incorporators are H. W. Davey, M. S. Reeve and E. F. Mack, Jr. The company is represented by Hyman Dominitz, 152 West 42d St.

THE MOUNTAIN LIME CO., Los Angeles, Cal., has been incorporated with a capital of $500,000, to manufacture lime and affiliated products. The incorporators are V. C. Hickson, W. J. Little and T. P. Lamb. The company is represented by Randal, Bartlett & White, 605 California Bldg.

THE M. & S. SHELLAC CO., Newton, Mass., has been incorporated with a capital of $3,600, to manufacture shellac, varnish and kindred products. Thomas J. Mitchell is president; and Isidor Slotwick, 87 Congress St., Chelsea, Mass., treasurer.

THE SATISFACTO PRODUCTS CO., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are O. W. Sample, H. Gerbitz and T. J. Ward. The company is represented by M. A. Barney, 154 Nassau St., New York.

THE HARDMAN PRODUCTS CO., Caldwell, N. J., has been incorporated with a capital of $50,000, to manufacture rubber products. The incorporators are J., Herbert V. and L. N. Hardman, 29 Elizabeth St., Caldwell.

THE MAXWELL PAINT CO., Philadelphia, Pa., has been incorporated with a capital of $10,000, to manufacture paint, varnish, etc. H. C. Middletown, Jr., Moorestown, N. J., is treasurer.

THE DORADIAN OIL CO., El Dorado, Ark., has been incorporated with a capital of $125,000, to manufacture petroleum products. The incorporators are F. N. Fisher, A. J. Falls and Benjamin R. Henderson, all of Memphis, Tenn.

THE TUCAN CLAY PRODUCTS CO., Chicago, Ill., has been incorporated with a capital of $250,000, under Delaware laws, to manufacture clay products. The incorporators are C. W. Smith, J. N. Fulton and J. M. Fitzpatrick, Chicago. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE ASBESTOS PRODUCTS MFG. CO., Hoboken, N. J., has been incorporated with a capital of $10,000, to manufacture asbestos goods of various kinds. The incorporators are William D. Crumpton, Frank Riehl and Elwood J. Wilson, 1021 Grand St., Hoboken.

THE MAGNUS CHEMICAL CO., Brooklyn, N. Y., has been incorporated with a capital of $90,000, to manufacture chemicals and chemical byproducts. The incorporators are W. M. and W. J. Campbell, and E. Magnuson. The company is represented by Henry Amerman, 233 Broadway, New York.

THE WYATT RUBBER CO., 233 East 22d St., Baltimore, Md., has been incorporated with a capital of $50,000, to manufacture rubber products. The incorporators are Charles M. Reckord and Francis J. Hamill.

THE A. B. HURST CO., Kendall, Fla., has been incorporated with a capital of $25,000, to manufacture starch and affiliated products. A. B. Hurst, is president; W. T. Tomlinson, vice-president; and John B. Hurst, secretary, all of Kendall.

THE PINE TREE PULP CO., Gardiner, Me., has been incorporated with a capital of $100,000, to manufacture paper-pulp and affiliated products. J. Harold Machette is president and treasurer. Robert K. Eaton, Gardiner, represents the company.

THE LAWLOR-MCCORMICK CO., New Brunswick, N. J., has been incorporated with a capital of $50,000, to manufacture coal-tar byproducts and affiliated specialties. The incorporators are Joseph J. Lawlor, William J. Lawlor and Clifford J. McCormick. The company is represented by Neilson & Hamilton, New Brunswick.

THE LIBERTY GLASS CO., Wilmington, Del., has been incorporated under state laws, with capital of $200,000, to manufacture glass products. The company is represented by the Capital Trust Co., Dover, Del.

THE APEX COLOR CO., Providence, R. I., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture colors, dyes and kindred products. The incorporators are Herbert J. Humphres, and Clifton I. Munroe, Providence; and Ogden R. Lindsley, Central Falls, R. I.

THP WELLSTAN OIL CO., New York, N. Y., has been incorporated with a capital of $200,000, to manufacture oil products. The incorporators are Charles Newburg, Anthony N. Roderink and Randolph S. Barrie, New York. The company is represented by the United States Corporation Co., 65 Cedar St.

THE EXCELSIOR LEATHER CO., New York, N. Y., has been incorporated with a capital of $30,000, to manufacture leather products. The incorporators are W. and E. Fried, and E. Tucker. The company is represented by Abraham Karp, 350 Broadway.

KERR, WILSON & CO., INC., Roanoke, Va., has been incorporated with a capital of $250,000, to manufacture tannin extracts for leather working, dye products, etc. George A. Kerr is president; Walter F. Wilson, vice-president; and J. Calvin Moss, secretary-treasurer, all of Lynchburg, Va.

THE AMERICAN COBALT PRODUCTS CO., Jersey City, N. J., has been incorporated with a capital of $1,500,000, to manufacture cobalt compounds and affiliated products. The company is represented by the Corporation Trust Co., 15 Exchange Pl., Jersey City.

Manufacturers' Catalogs

THE K-B PULVERIZER CO., INC., New York, N. Y., has issued a folder on the Pulverburner.

THE PIRON COAL DISTILLATION SYSTEMS, New York, N. Y., in Bulletin 1 illustrates and describes coke and gas oven byproduct plants and distillation recovery systems.

C. G. BUCHANAN CO., INC., New York, calls attention to Bulletin 13, on Type "C" Buchanan crushing rolls. On page 2 is given a brief history of the original and first introduction of rolls. This in itself would probably be of little interest to the average reader, but the data given on the large capacity and the comparatively small amount of power required to operate these early and imperfect machines must be of keen interest to any one who is not thoroughly familiar with the use or possibilities of rolls as a crushing device for medium fine crushing. This company has endeavored to make clear the limitations of rolls in regard to size of pieces that rolls can economically handle and the reduction that can be made in a single pass, and convenient tables and diagrams are given on pages 8 and 10. Simple tables of capacities are given on pages 12 and 13, enabling the users of rolls to determine quickly the size, speed and number of rolls to be used for accomplishing any given amount of work.

THE EAGLE-PICHER LEAD CO., Chicago, Ill., has issued an attractive booklet on Eagle-Picher Products. A "Lead Tree" chart is given showing the comprehensiveness of the company's operations; composition and use of white lead, blue lead, lithrage, red lead and orange mineral, etc.; a list of metal products which find most general use in the lead-consuming industries; and specifications of lead pipes, traps, roof flanges and lead bottles and specialties.

New Publications

PROBLEMS FOR RESEARCH TRAINING. By *Research Committee*, H. A. Shoule, chairman. 30 pp. Scientech Club, Indianapolis, Ind.

This little pamphlet addressed to the members of the scientific and technical faculties of Indiana colleges and universities lists 175 different research problems awaiting solution in the fields of botany, chemistry, engineering and physics. These problems, for the most part, have been suggested by active professional men who are appreciative of the actual needs of the industries they represent.

OIL FLOW IN PIPE LINES. By *R. S. Danforth*. Ten charts and two pages of instructions. Published by King Knight Co., San Francisco, Cal. Price $3.

A series of charts for use in solving oil-pumping problems have been prepared by the author using the formulas and method of computation explained in a previous bulletin, "Friction Pressure Loss in Oil Pipe Lines" published by the Kinney Manufacturing Co., of Boston, Mass.

THE AMERICAN ACADEMY OF ARTS AND SCIENCES has issued a booklet on "The Potential of the Thallium Electrode and the Free Energy of Formation of Thallous Iodide," by Grinnell Jones and Walter Cecil Schumb.

THE UNIVERSITY OF ILLINOIS has issued bulletins on "Investigation of Warm-Air Furnaces and Heating Systems," by A. C. Willard, A. P. Kratz and V. S. Day; "The Functions of the Engineering Experiment Station of the University of Illinois," by Charles Russ Richards, and "Some Conditions Affecting the Usefulness of Iron Oxide for City Gas Purification," by William A. Dunkley.

THE IOWA STATE COLLEGE has issued a bulletin on "Effects on Concrete of Immersion in Boiling Water and Oven Drying," by W. J. Schlick.

THE FEDERAL POWER COMMISSION has issued a booklet on Rules and Regulations as amended by Order No. 11 of June 6, 1921, governing the administration of the federal water power act, with copies of the act, of amendment thereto, and of orders Nos. 1 to 11 inclusive.

Coming Meetings and Events

ACADEMY OF POLITICAL SCIENCE will hold its forty-first annual meeting at the Hotel Astor, New York City, Nov. 4 and 5.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN IRON AND STEEL INSTITUTE will hold its twentieth general meeting at the Hotel Commodore, New York City, on Friday, Nov. 18.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA is holding its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.